US009351534B2

(12) **United States Patent**
Peikert et al.

(10) **Patent No.: US 9,351,534 B2**
(45) **Date of Patent: *May 31, 2016**

(54) **COMPOSITE SHOE SOLE, FOOTWEAR CONSTITUTED THEREOF AND METHOD FOR PRODUCING THE SAME**

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(73) Assignee: **W. L. Gore & Associates GmbH**, Putzbrunn (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/693,316**

(22) Filed: **Dec. 4, 2012**

(65) **Prior Publication Data**

US 2013/0091738 A1 Apr. 18, 2013

Related U.S. Application Data

(62) Division of application No. 12/281,527, filed as application No. PCT/EP2007/001821 on Mar. 2, 2007.

(30) **Foreign Application Priority Data**

Mar. 3, 2006 (DE) 10 2006 010 007
Jan. 17, 2007 (DE) .... 20 2007 000 667 U

(51) **Int. Cl.**
A43B 7/06 (2006.01)
A43B 13/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A43B 13/026*** (2013.01); ***A43B 7/06*** (2013.01); ***A43B 7/08*** (2013.01); ***A43B 7/125*** (2013.01); ***A43B 13/12*** (2013.01)

(58) **Field of Classification Search**
CPC A43B 7/06; A43B 7/08; A43B 7/12; A43B 7/125; A43B 13/00; A43B 13/02; A43B 13/023; A43B 13/026; A43B 13/12
USPC .... 36/3 R, 3 A, 3 B, 114, 8.1, 25 R, 30 R
See application file for complete search history.

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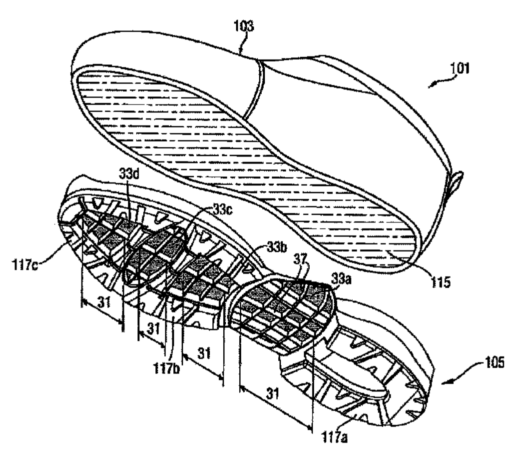
(57) **ABSTRACT**

A water-vapor permeable shoe-sole combination (**15**) with an upper side (**5**) having at least on through hole (**31**) extending through the thickness of the shoe-sole combination, a barrier unit (**35**) with an upper side forming at least part of the upper side (**50**) of the shoe-sole combination, made of a water-vapor permeable barrier material (**33**) that forms a barrier against penetration of foreign bodies, by means of which the at least one through hole (**31**) is closed in a water-vapor permeable manner, a reinforcement device (**25**) formed for mechanical reinforcement of the shoe-sole combination (**105**), constructed with at least one reinforcement web (**37**) arranged on at least one surface of the barrier material (**33**) and at least partially crossing the at least one through hole (**31**), and at least one walking-sole part (**117**) arranged beneath the barrier unit (**35**).

13 Claims, 19 Drawing Sheets



(51) **Int. Cl.**

A43B 13/12	(2006.01)
A43B 7/08	(2006.01)
A43B 7/12	(2006.01)

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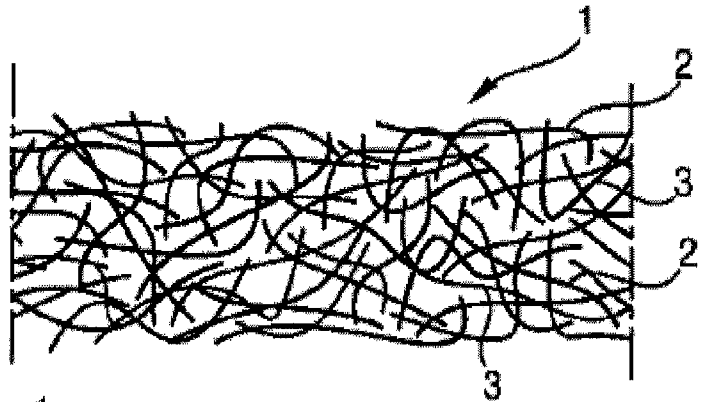


Fig. 1

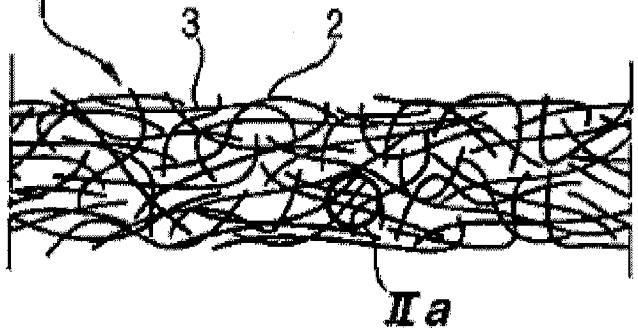
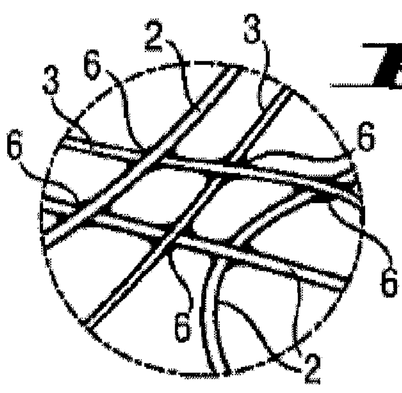


Fig. 2



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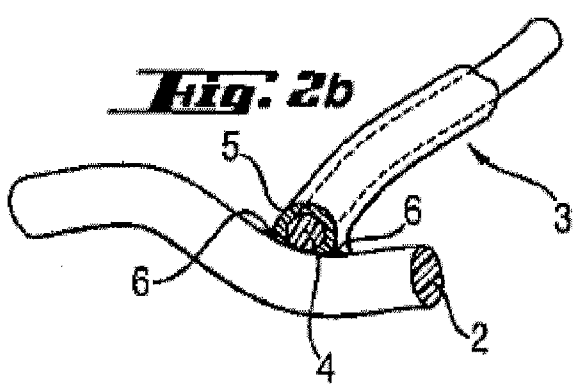

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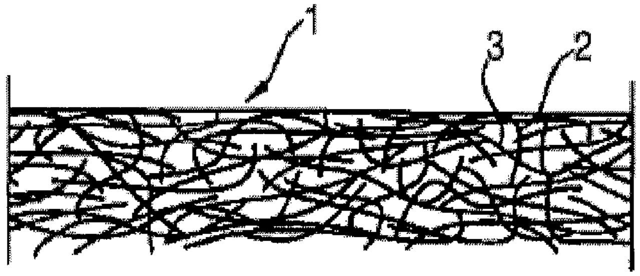
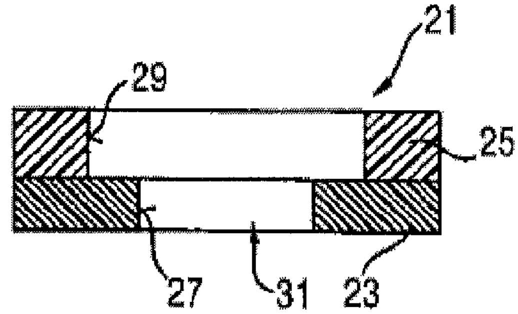


Fig. 3

Fig. 4



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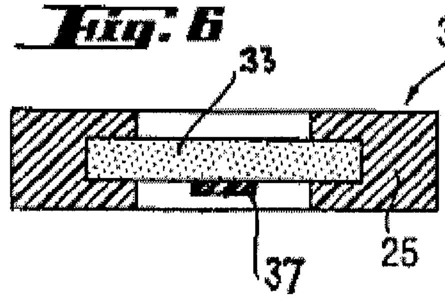

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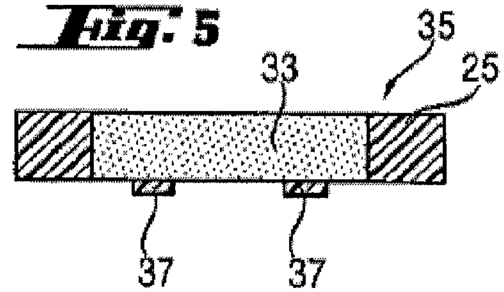

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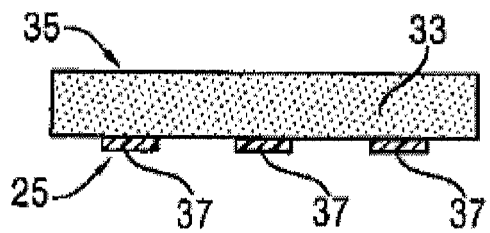

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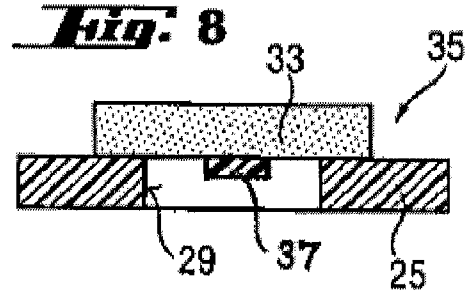

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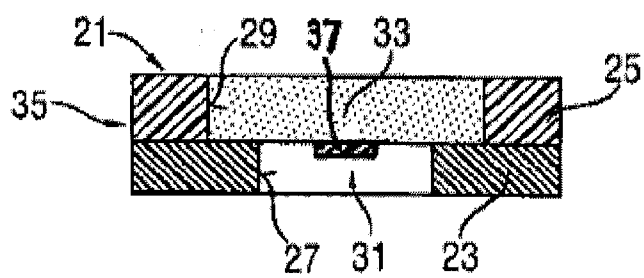

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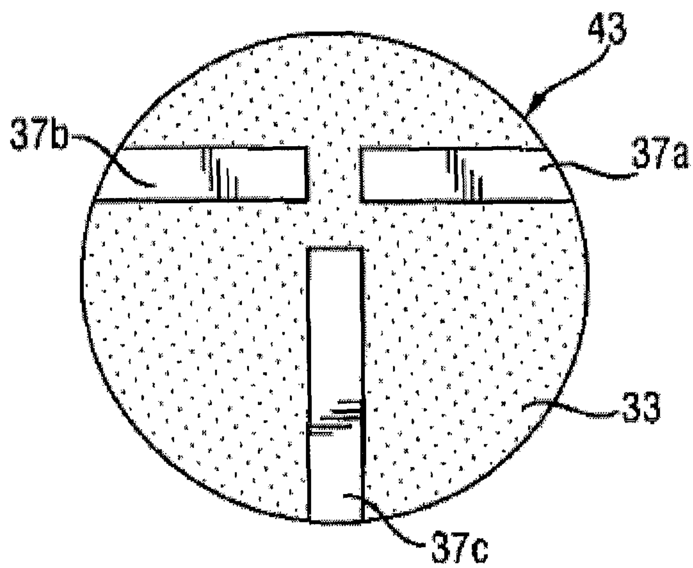

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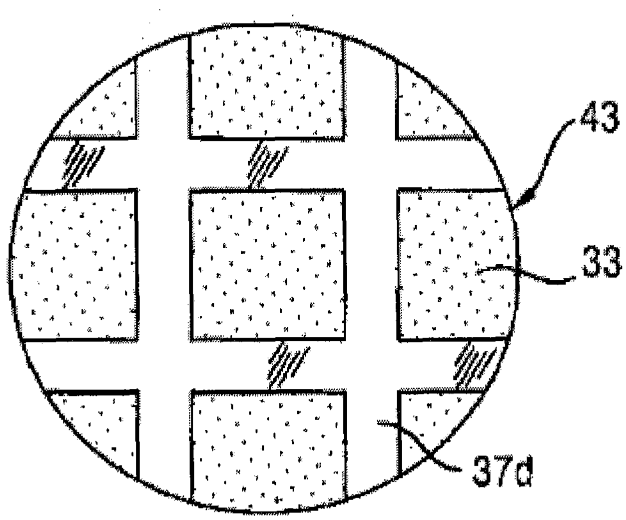

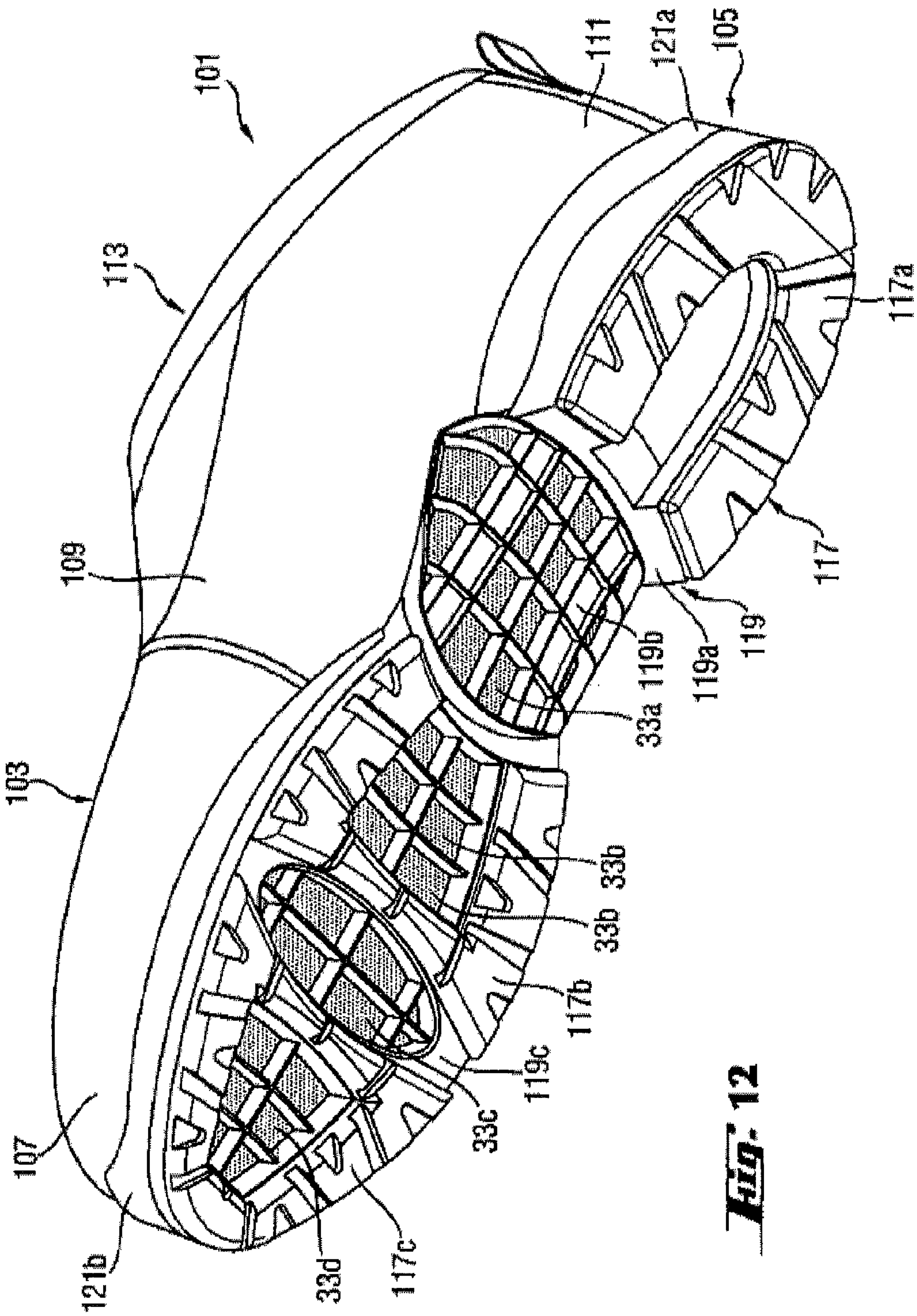
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Fig. 12

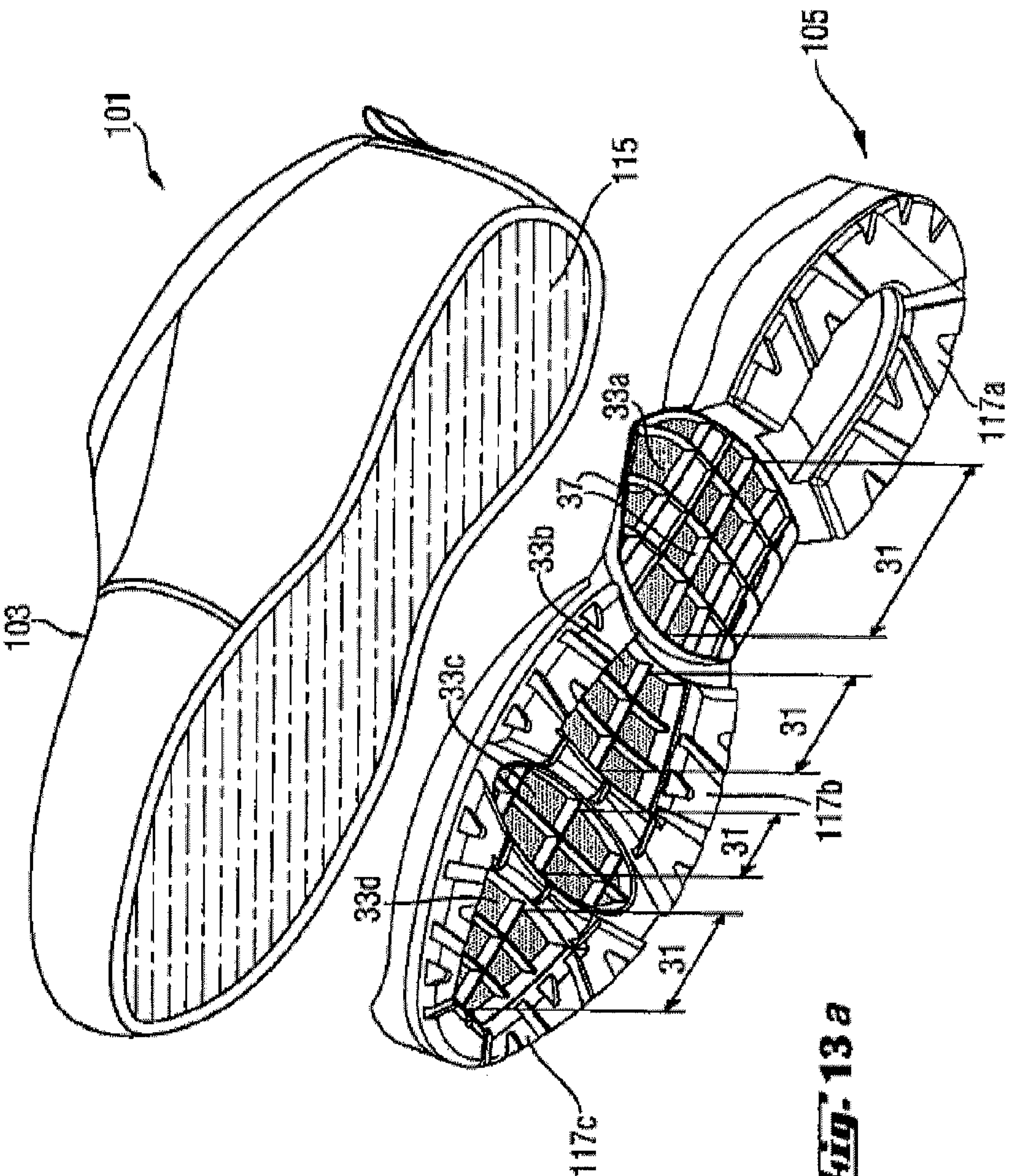
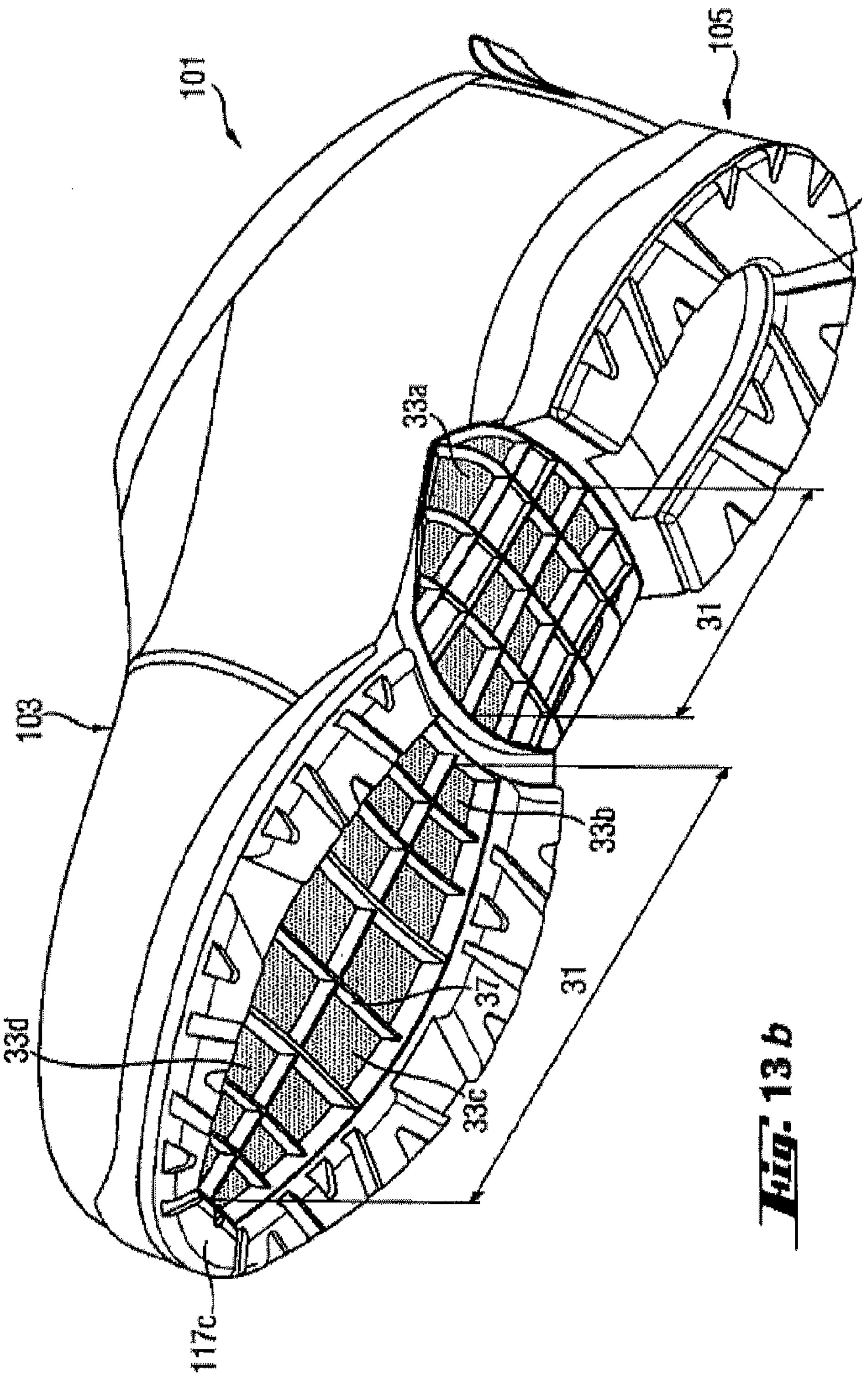


Fig. 13a



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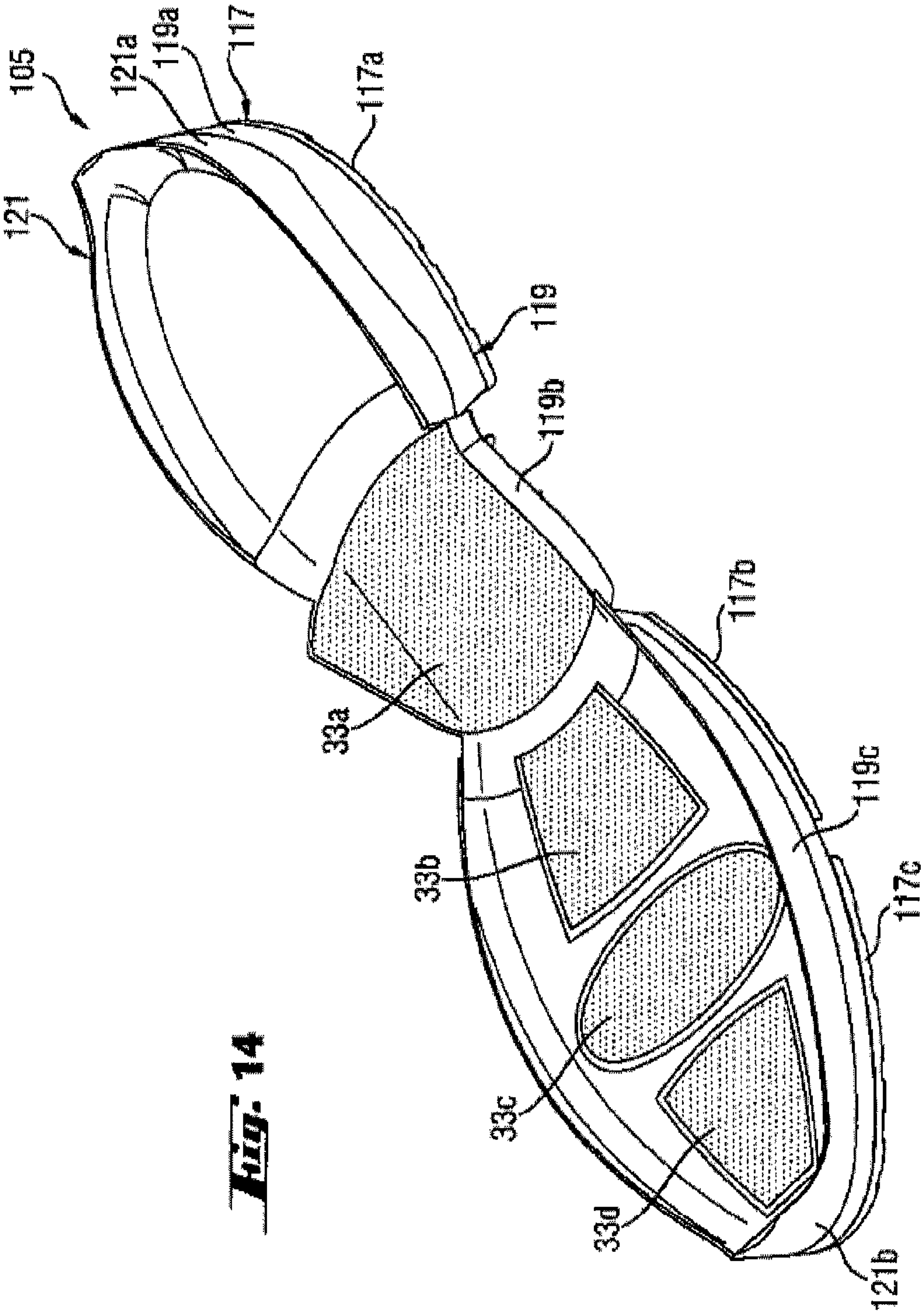
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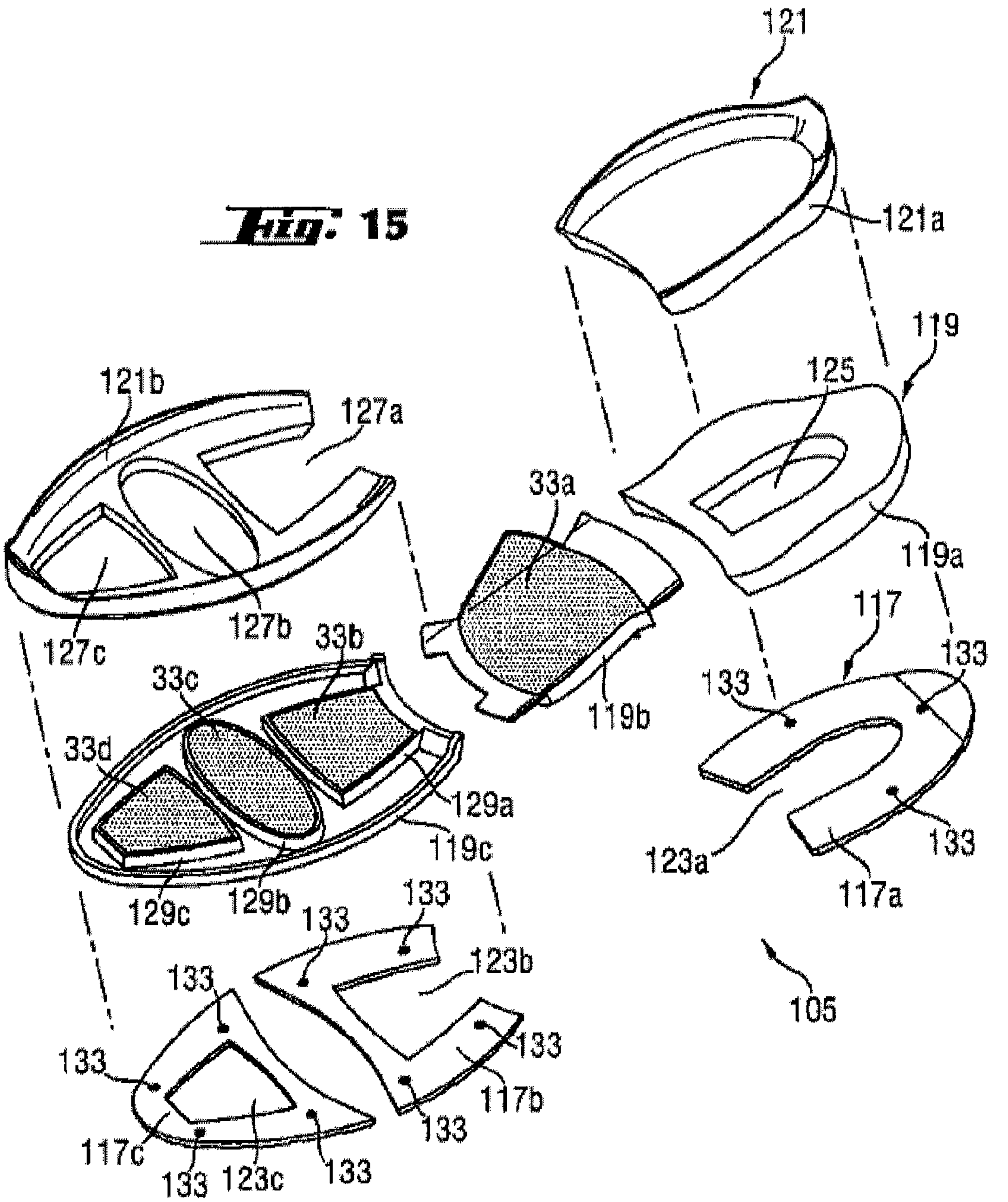
Fig. 14

Fig. 15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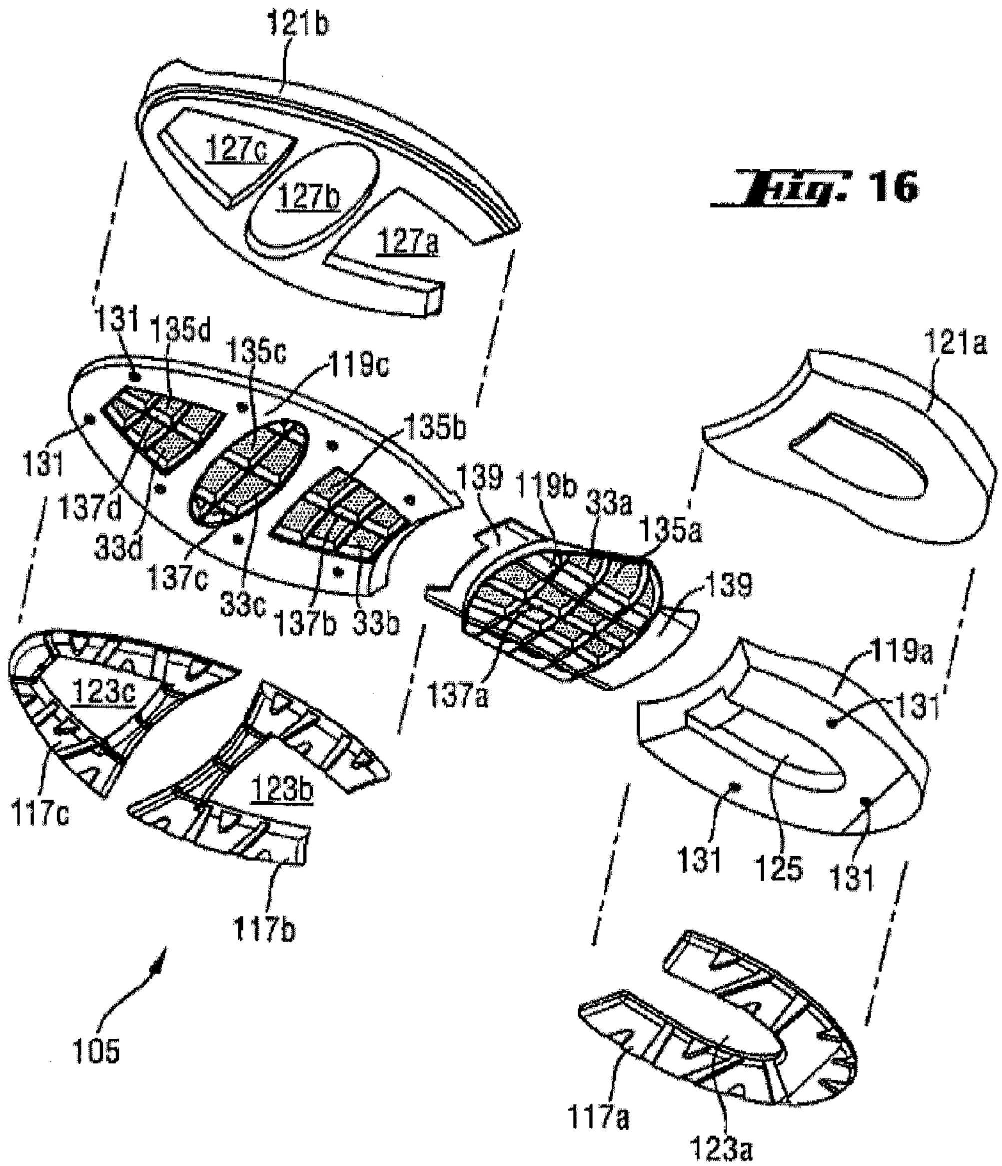
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Fig. 16

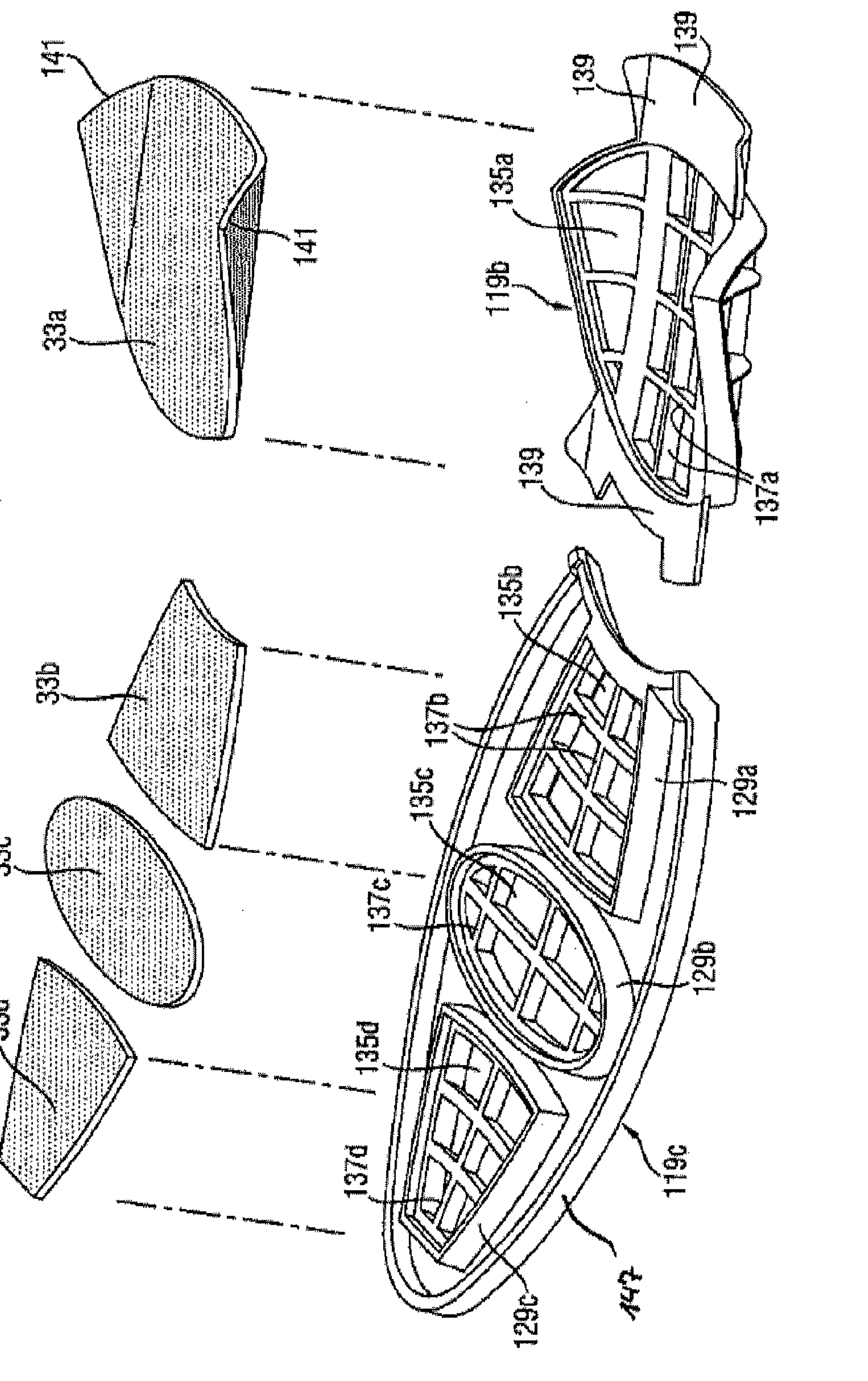
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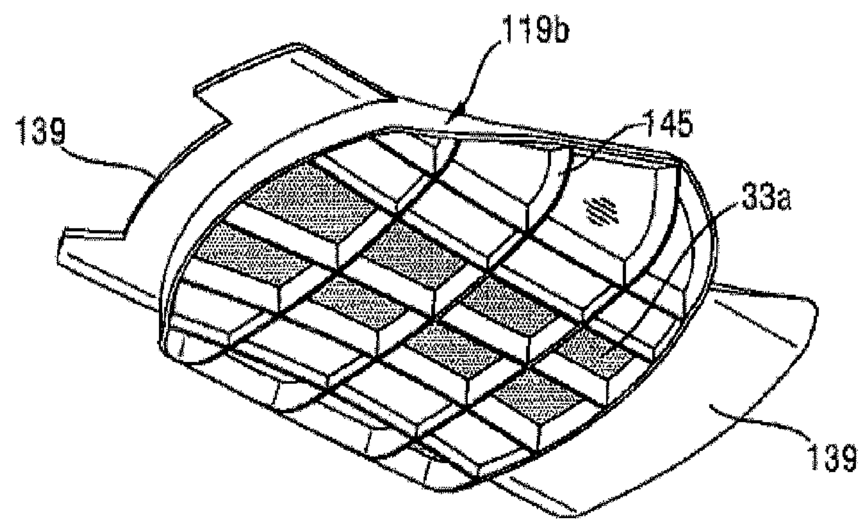
Fig. 17

Fig. 18



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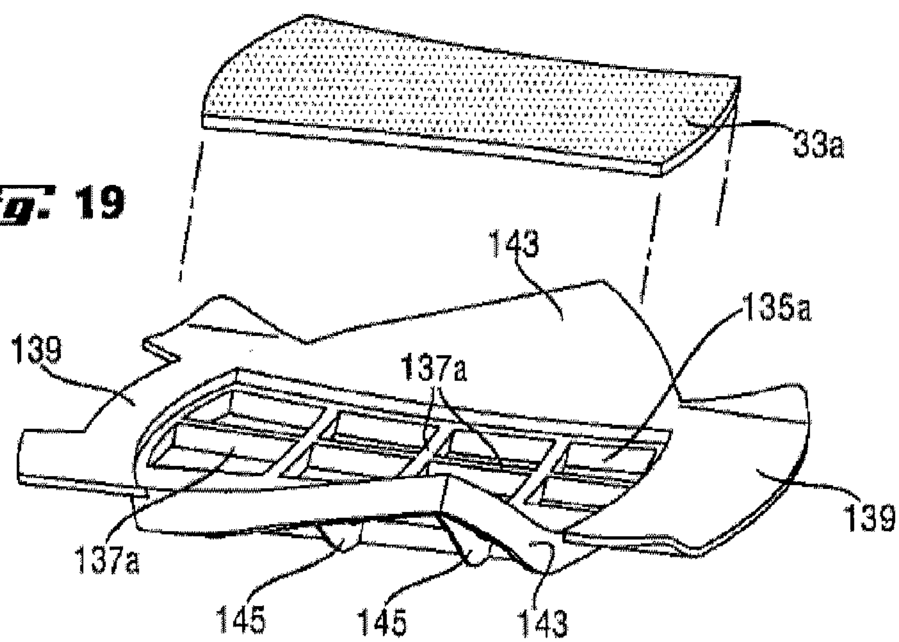

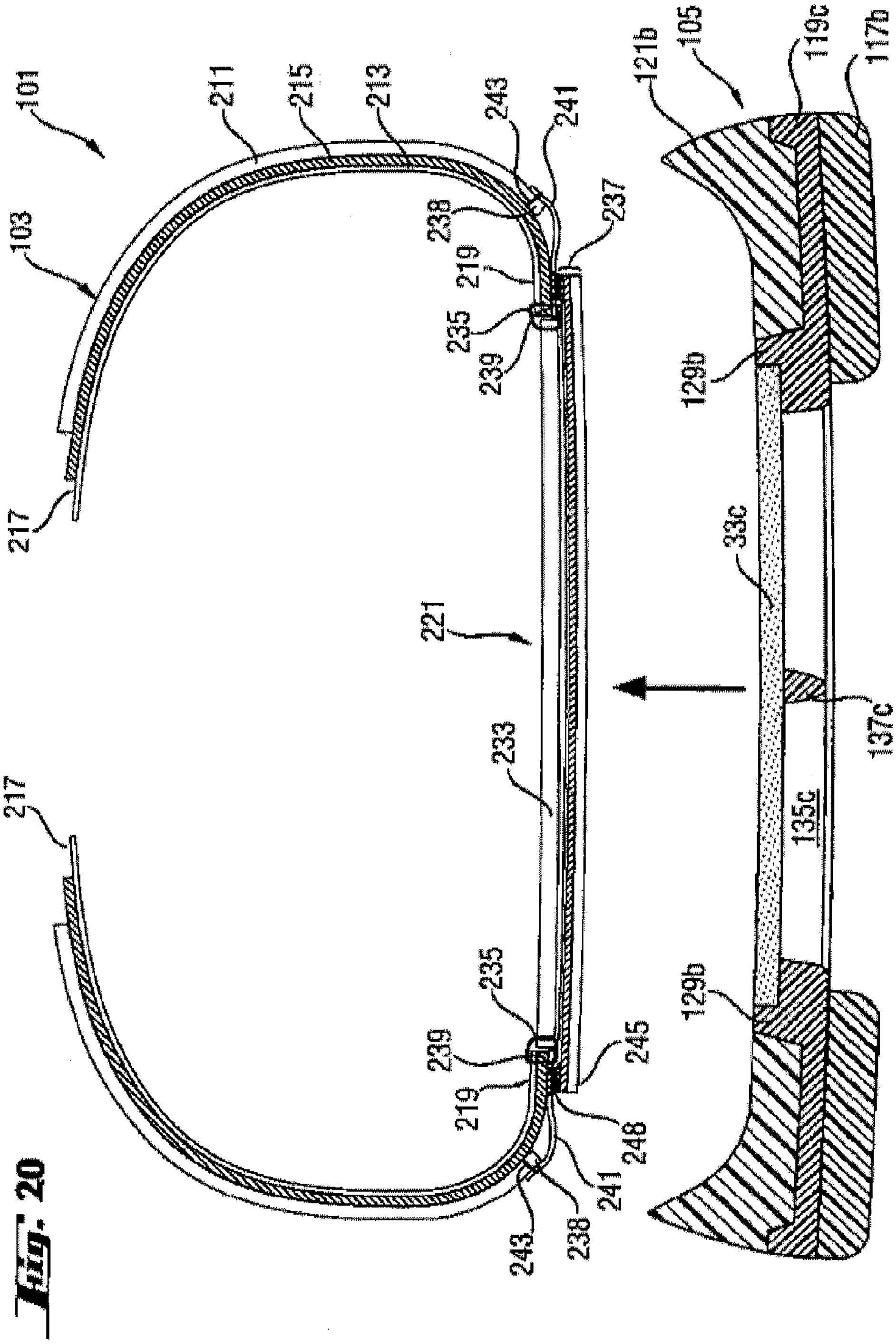
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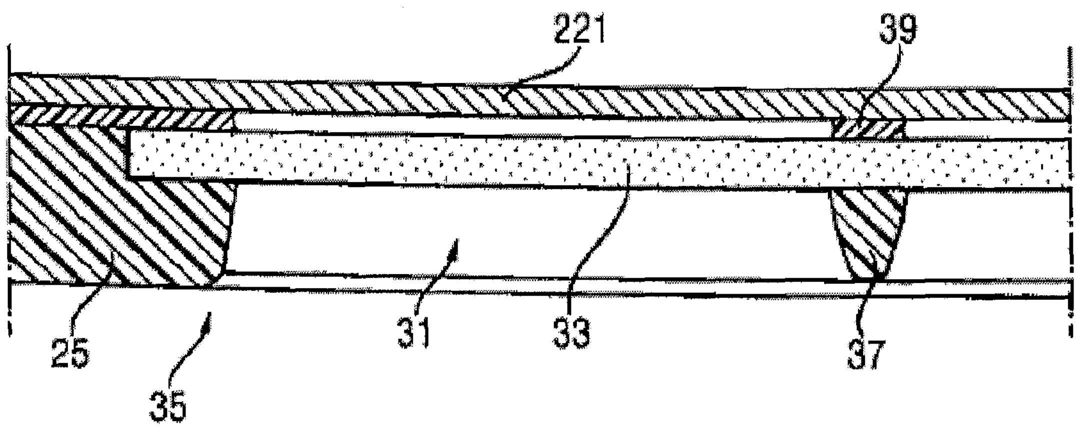
Fig. 20

Fig. 21



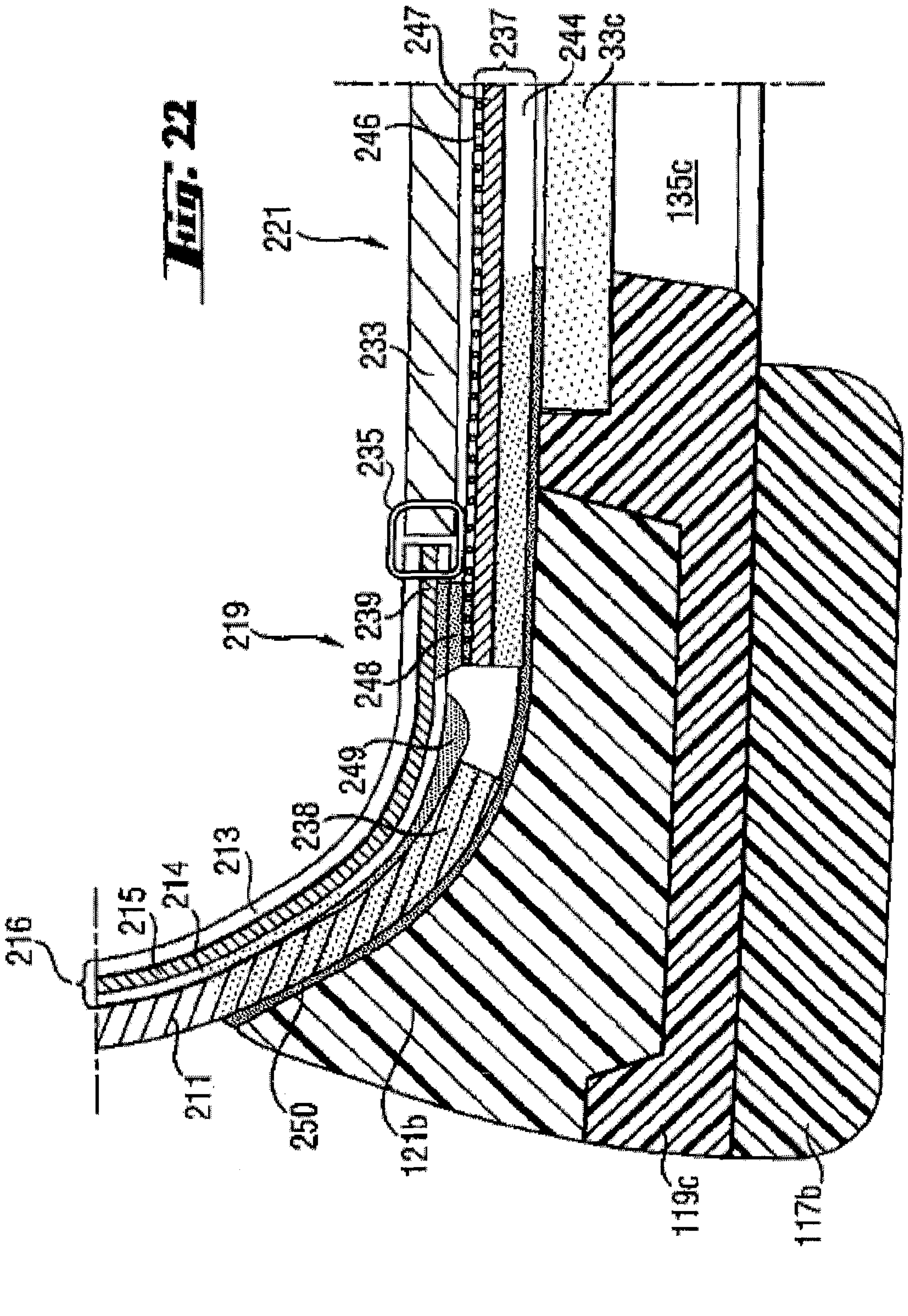


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Fig. 22

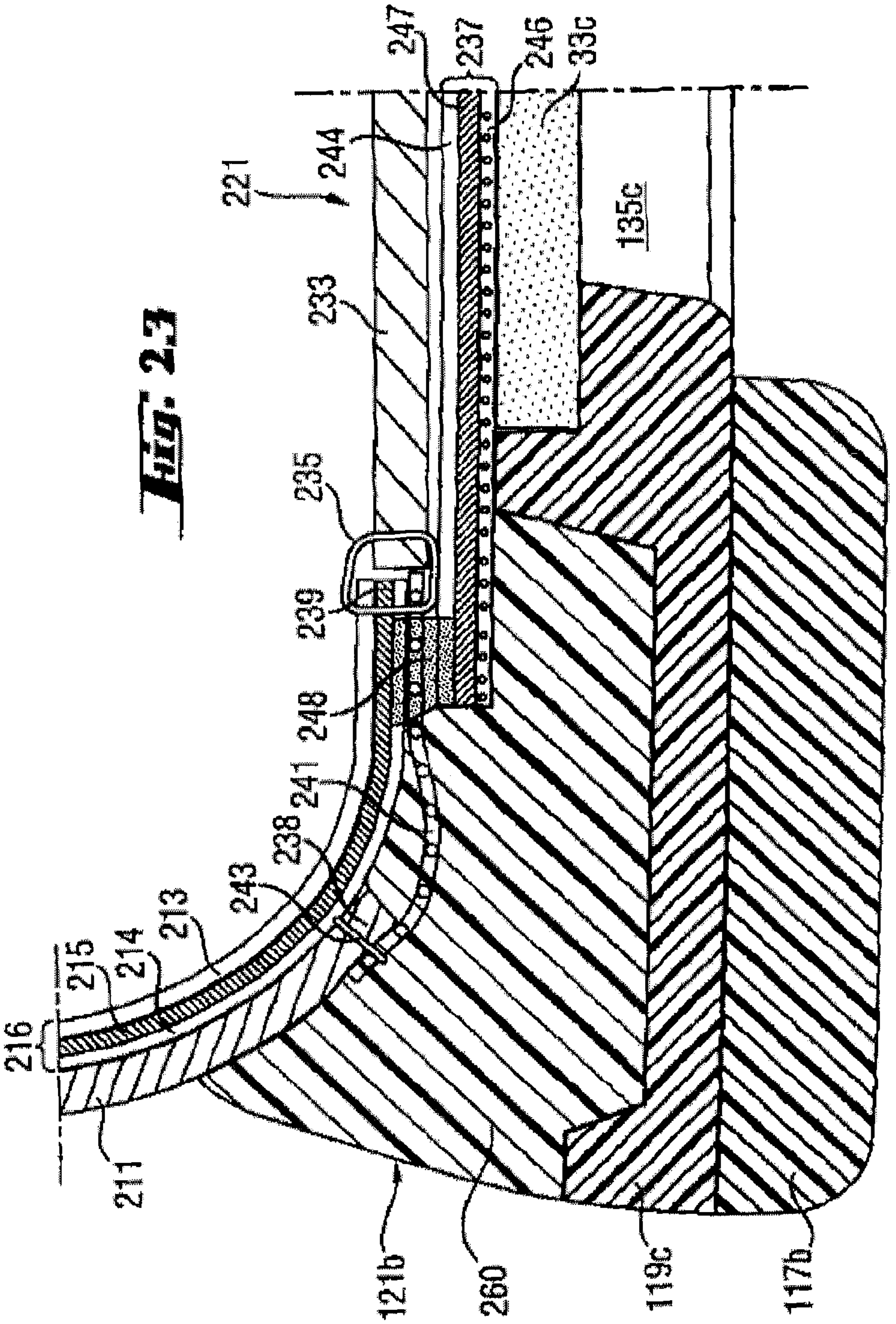
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Fig. 23

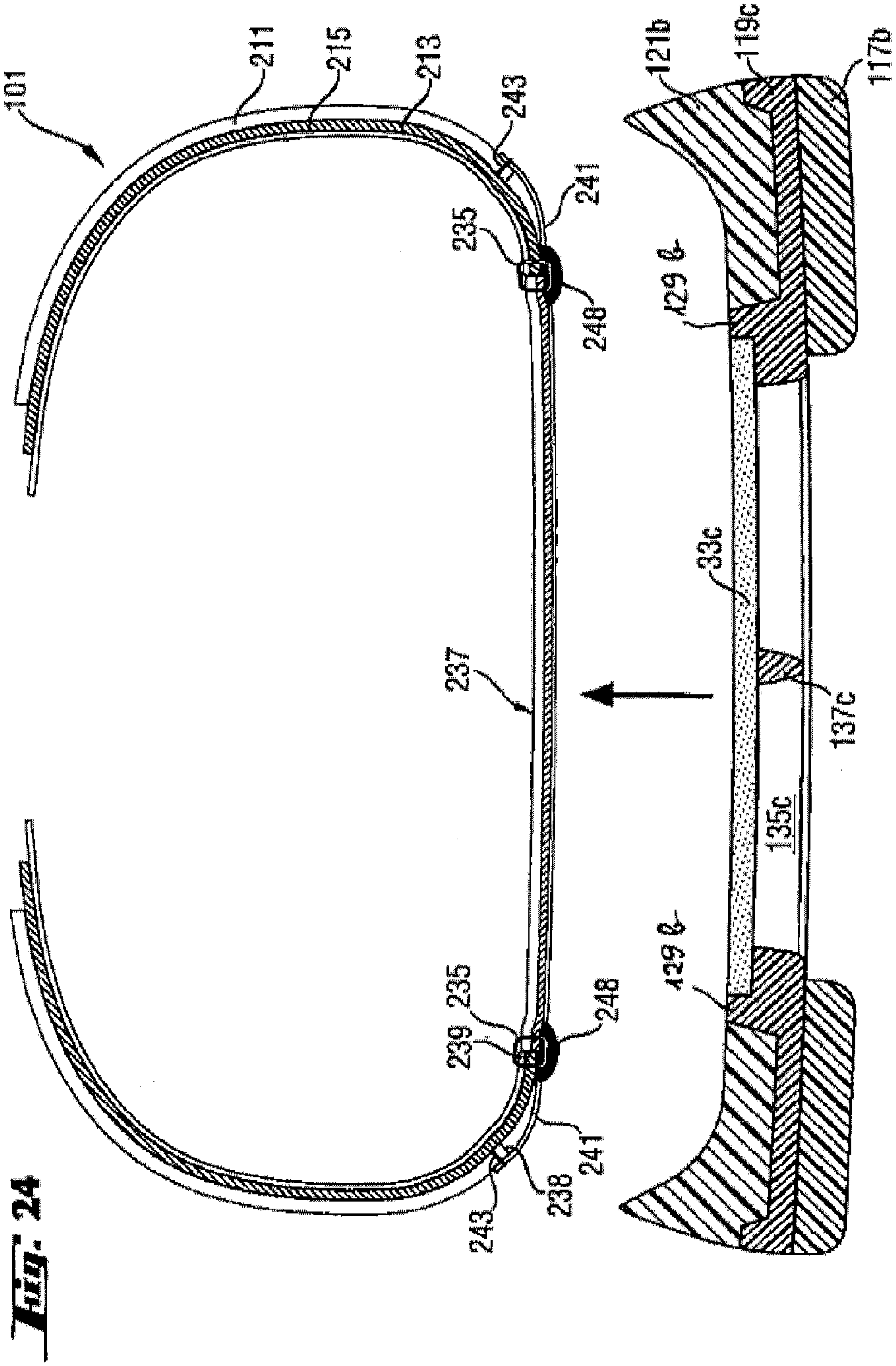
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Fig. 24

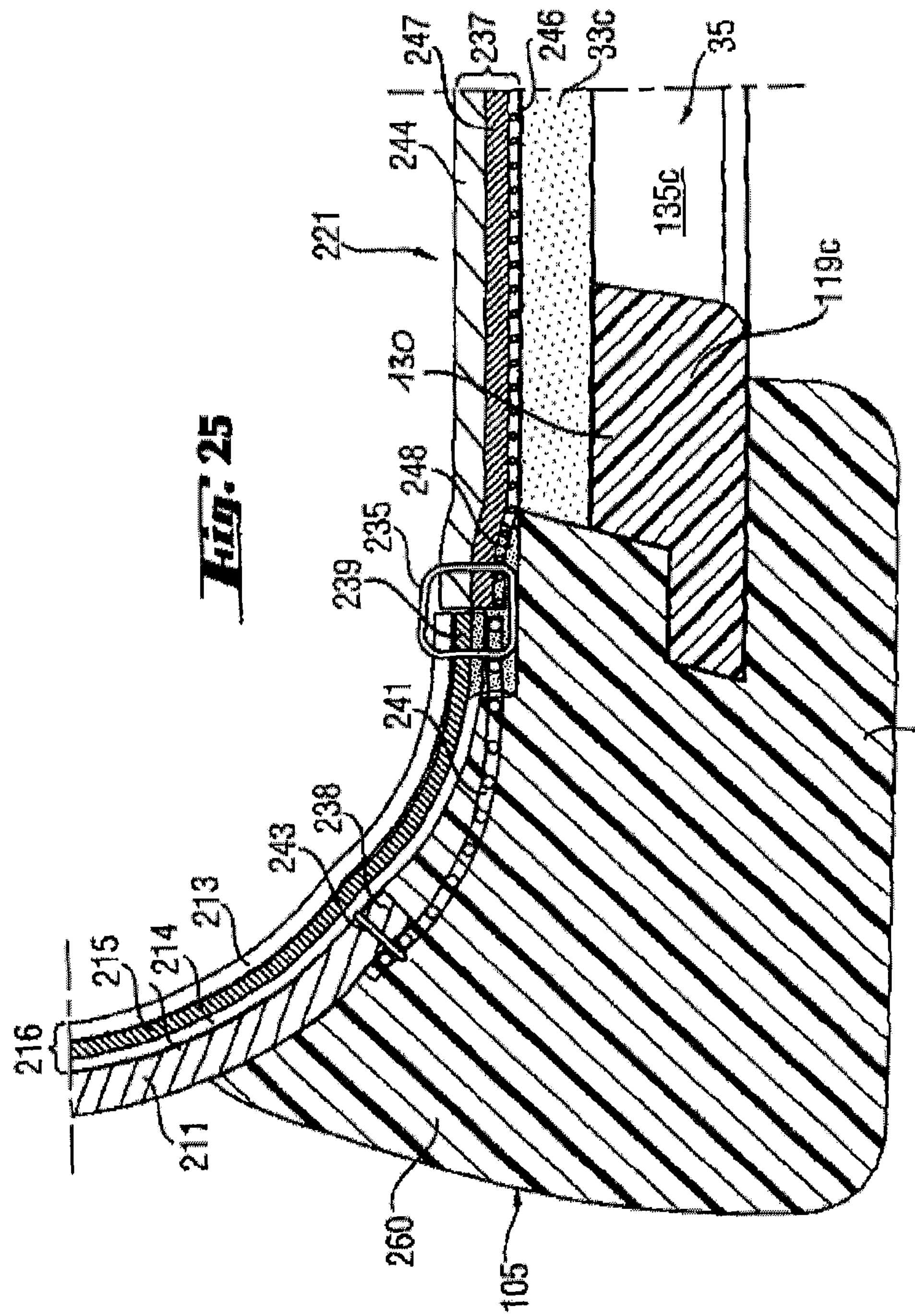
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Fig. 25

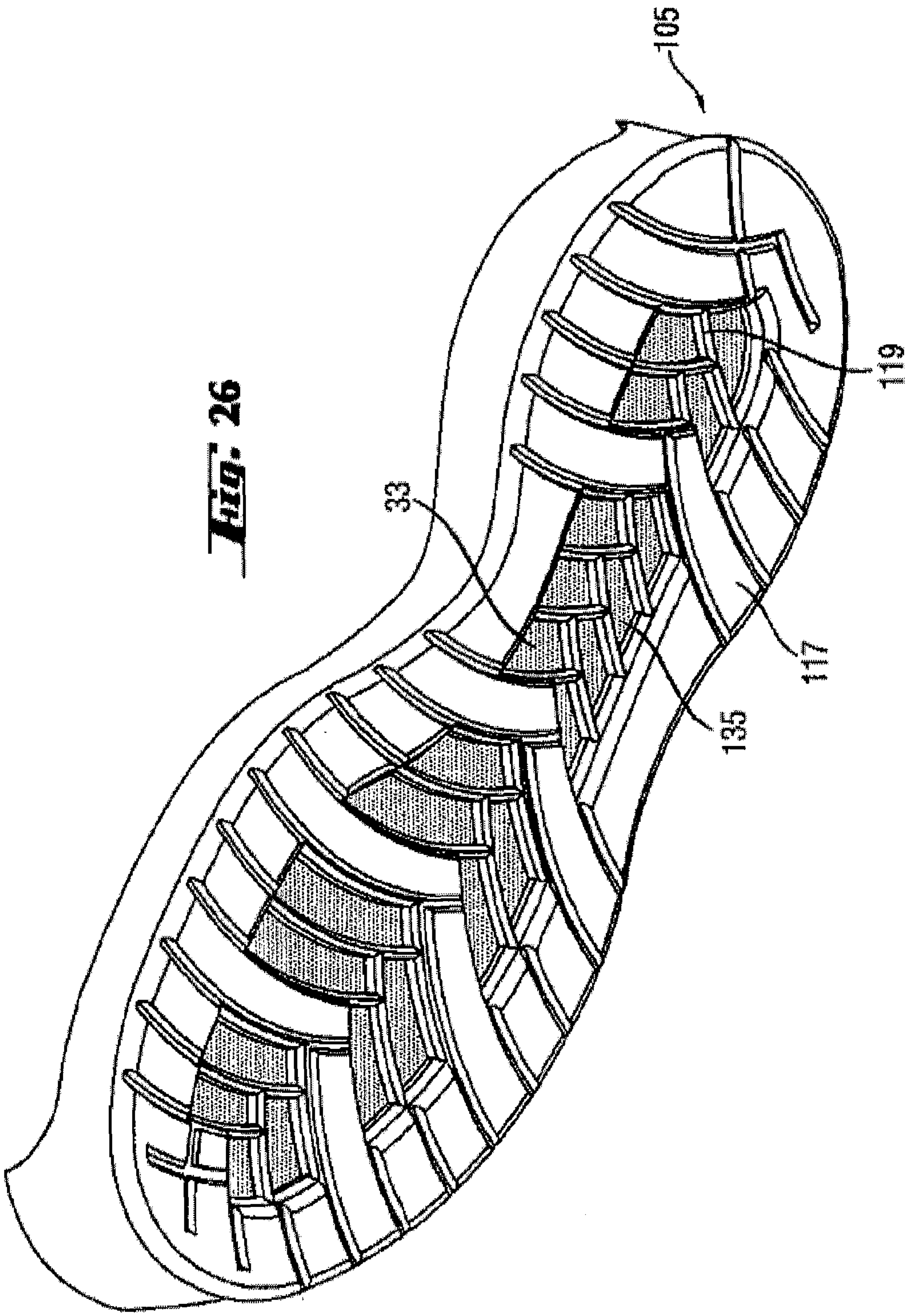

Fig. 26

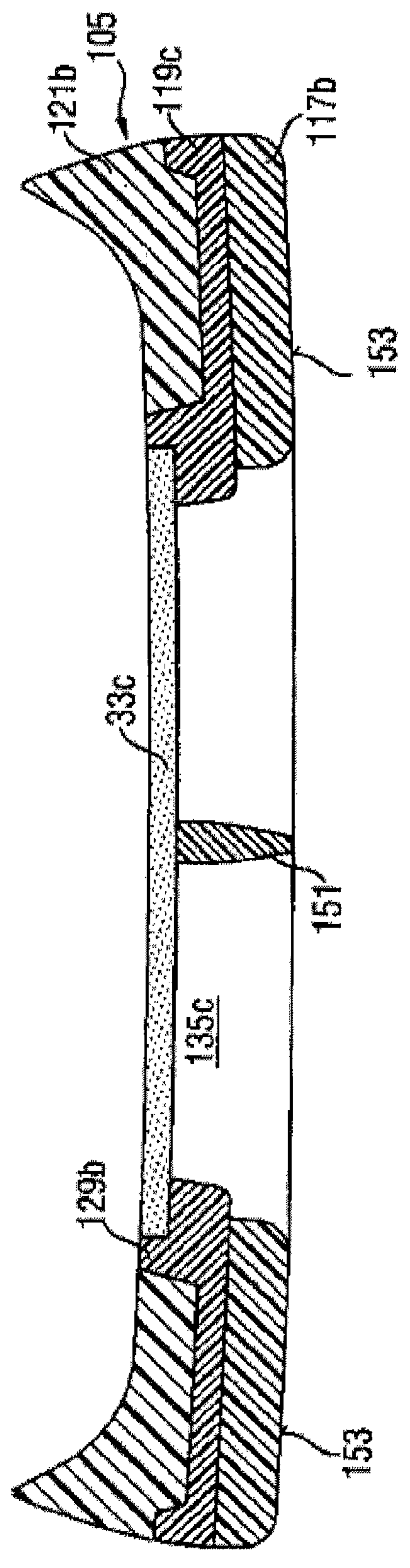

Fig. 27

COMPOSITE SHOE SOLE, FOOTWEAR CONSTITUTED THEREOF AND METHOD FOR PRODUCING THE SAME

RELATED APPLICATION

The present application is a divisional application of pending U.S. patent application Ser. No. 12/281,527 filed Sep. 3, 2008, further claims the benefit of PCT/EP2007/001821 filed Mar. 2, 2007, and further claims the benefit of German Patent Application Nos. DE 20 2007 000 667.5 filed Jan. 17, 2007 and DE 10 2006 010 007.7 filed Mar. 3, 2006.

The invention relates to a composite shoe sole, footwear constructed with it, as well as a method for producing such footwear.

The need to decide, as an alternative, either on a waterproof shoe-bottom structure that blocks sweat moisture or on one permeable to sweat moisture, but also water-permeable, no longer exists, since there have been shoe-bottom structures that are waterproof, despite water-vapor-permeability, specifically based on the use of a perforated outsole or one provided with trough holes and a waterproof, water-vapor-permeable functional layer arranged above it, for example, in the form of a membrane. Documents EP 0,275,644 A2, EP 0,382,904 A2, EP 1,506, 723 A2, EP 0,858,270 B1, DE 100 36 100 C1, EP 959,704 B1, WO 2004/028,284 A1, DE 20 2004 08539 U1, and WO 2005/065,479 A1 provide examples.

Since the human foot has a strong tendency to sweat, the present invention seeks to make footwear available that has a shoe-bottom structure with particularly high water-vapor-permeability, without seriously compromising its stability.

In footwear with an outsole with small trough holes according to EP 0,382,904 A2, sufficient stability of the sole structure can be achieved with normally stiff outsole material, but only with moderate water-vapor-permeability of the shoe bottom.

Sole structures according to EP 959,704 B1 and WO 2004/028,284 A1, which have an outsole favoring higher water-vapor-permeability consisting essentially of only a peripheral frame for incorporation of water-vapor-permeable material in addition to a number of separate outsole cleats, which are supposed to protect a membrane situated above them from penetration of foreign bodies, such as small pebbles, but themselves are not separately stable, do not provide a degree of stabilization of the sole structure, as is desired for many types of footwear. The outsole in WO 2004/028,284 A1 is formed from the peripheral frame and a number of outsole cleats, which are distributed over the bottom of the sole within the peripheral frame.

The situation is similar in the sole structures according to DE 20 2004 08539 U1 and WO 2005/065479 A1, in which waterproof, water-vapor-permeable inserts are inserted into large-area openings of the outsole, which have a membrane that covers the opening in a waterproof manner and beneath it a laminated mesh serving as protection of the membrane against penetration of foreign objects. Since both the membrane and the laminated mesh consist of relatively soft material, so that they can scarcely make a contribution to stabilization of the sole structure, the stability of the sole structure is weakened at the sites of the large-area openings.

Better stabilization of the shoe-bottom structure was achieved in an athletic shoe according to DE 100 36 100 C1, whose outsole is formed from outsole parts with large-area openings, in that the outsole parts are arranged on the bottom of a support layer, consisting of compression-proof plastic, which is provided with mesh-like openings at the sites that lie above the large-area openings of the outsole parts and is

therefore water-vapor-permeable, like the outsole parts. A membrane is arranged between a support layer and an insole situated above it, which is provided with holes for water-vapor-permeability, with which not only is waterproofness with water-vapor-permeability to be achieved, but it is also supposed to prevent small pebbles that the mesh openings of the support layer cannot keep out from penetrating into the interior of the shoe. The membrane, which is easily damaged by mechanical effects, is therefore supposed to offer protection, which it itself actually requires.

Other solutions, for example, according to EP 1,506,723 A2 and EP 0,858,270 B1, propose a protective layer beneath the membrane as protection against the penetration of foreign objects, such as pebbles that have entered through a perforated outsole.

In embodiments of EP 1,506,723 A2, the membrane and the protective layer are joined to each other by spot gluing, i.e., by means of a glue pattern applied as a dot matrix. Only the surface part of the membrane not covered by glue is still available for water-vapor transport. The membrane and the protective layer then form a glue composite that either forms a composite sole with an outsole that is attached as such to the shaft bottom of the footwear or forms a part of the shaft bottom, onto which an outsole still has to be attached.

In another embodiment of EP 1,506,723 A2, the outsole is divided in two in terms of thickness, both outsole layers are provided with flush trough holes of relatively small diameter, and the protective layer is arranged between the two outsole layers. The membrane in the finished footwear is situated on the top of the outsole. Since only the trough hole-surface part of this outsole is available for water-vapor passage, only a correspondingly smaller part of the membrane surface can have an effect on water-vapor passage. It has also turned out that standing air volumes inhibit water-vapor transport. Such standing air volumes are formed in the trough holes of this outsole, and their elimination by air circulation through the outsole is adversely affected by the protective layer. Added to the effect that the surface parts of the membrane that lie outside the trough holes of the outsole and makeup a significant percentage of the total membrane surface cannot have an effect on water-vapor transport is the fact that the surface parts of the membrane opposite the trough holes also have only a restricted effect on water-vapor transport.

It is now a common division of labor in the production of footwear that one manufacturer produces the shoe shaft and another manufacturer is responsible for producing the corresponding shoe sole or the corresponding composite shoe sole or molding it onto the shoe shaft. Since the manufacturers of shoe soles are ordinarily less equipped and experienced in handling waterproof, water-vapor-permeable membranes, shoe-bottom concepts are worth seeking, in which the composite shoe sole, as such, has no membrane and the membrane forms part of the shaft bottom, onto which the composite shoe sole is arranged.

It is therefore the task of the present invention to provide footwear that has a shoe-bottom structure with permanent waterproofness and with particularly high water-vapor permeability, preferably achieving the highest possible stability of the shoe-bottom structure, a composite shoe sole suitable for this, as well as a method for producing footwear.

To solve this task, the invention makes available a water-vapor-permeable composite shoe sole according to claim **1**, footwear according to claim **92**, and a method for producing footwear according to claim **102**. Modifications of these objects are mentioned in the corresponding dependent claims.

According to a first aspect of the invention, a water-vapor-permeable composite shoe sole with a top is made available that has at least one opening extending through the thickness of the composite shoe sole. A barrier unit is provided with a top at least partially forming the top of the composite shoe sole, and with a water-vapor-permeable barrier material formed as a barrier against the penetration of foreign objects, by means of which the at least one opening is closed in a water-vapor-permeable manner. A stabilization device is assigned to the barrier material for mechanical stabilization of the composite shoe sole, which is constructed with at least one stabilization bar is arranged on at least one surface of the barrier material and at least partially bridges at least one opening.

At least one outsole part is arranged beneath the barrier unit. "Beneath the barrier unit" means that the at least one outsole part is arranged on the surface of the barrier unit facing the floor or ground. A situation is therefore achieved in which only the at least one outsole part assumes the function of walking or standing of the composite sole. The at least one outsole part is arranged on the barrier unit, so that no outsole parts are found in the at least one opening. Since the barrier unit does not represent or does not significantly represent the layer in the composite shoe sole that touches the ground, it is possible to optimize it with respect to its stabilizing properties, such as stiffness and torsion stiffness. In comparison with this, the outsole can be optimized with respect to its outsole function, for example, a material with limited wear and high adhesion can be chosen.

In one embodiment of the invention, the barrier material is a fiber composite with at least two fiber components that differ with respect to melting point. At least one part of a first fiber component then has a first melting point and a first softening temperatur range lying beneath it and at least one part of a second fiber component has a second melting point and a second softening temperatur range lying beneath it. The first melting point and the first softening temperatur range are higher than the second melting point and the second softening temperatur range. The fiber composite is thermally bonded, while maintaining water-vapor permeability in the thermally bonded area, as a result of thermal activation of the second fiber component with an adhesive softening temperatur lying in the second softening temperatur range.

"Melting point" is understood to mean, in the field of polymer or fiber structures, a narrow temperature range in which the crystalline areas of the polymer or fiber structure melt and the polymer converts to a liquid state. It lies above the softening temperatur range and is a significant characteristic for partially crystalline polymers. "Softening temperatur range" is understood to mean, in the field of synthetic fibers, a temperature range of different width occurring before the melting point is reached, in which softening, but no melting occurs.

This property is exploited in the barrier material to the extent that for both fiber components of the fiber composite, a material choice is made, so that the conditions according to the invention with respect to melting points and softening temperatur ranges are satisfied for both fiber components, and a temperature is chosen for the thermal bonding that represents an adhesive softening temperatur for the second fiber component, at which softening of the second fiber component occurs, in which case, its material exerts a gluing effect, so that at least part of the fibers of the second fiber component are thermally bonded to each other by gluing, so that bonding stabilization of the fiber composite occurs that is above the bonding obtained in a fiber composite with the same materials for the two fiber components by purely mechanical bonding, for example, by needle attachment of the fiber composite. The adhesive softening temperatur can also be chosen in such a way that softening of the fibers of the second fiber component occurs to an extent that not only are the fibers of the second fiber component glued to each other, but also partial or complete enclosure of individual sites of the fibers of the first fiber composite with softened material of fibers of the second fiber composite occurs, i.e., partial or full embedding of such sites of fibers of the first fiber composite in the material of fibers of the second fiber composite, so that a correspondingly increased stabilization bonding of the fiber composite occurs.

In one embodiment of the composite shoe sole according to the invention, the barrier material has a fiber composite with a first fiber component and a second fiber component with two fiber parts, whereby the first fiber component has a first melting point and a softening temperatur range lying beneath it, and a second fiber part of the second fiber component has a second melting point and a second softening temperatur range lying beneath it; the first melting point and the first melting-point range are higher than the second melting point and the second softening temperatur range, the first fiber part of the second fiber component has a higher melting point and a higher softening temperatur lying beneath it than the second fiber part, and the fiber composite, as a result of thermal activation of the second fiber part of the second fiber component, is thermally bonded, while retaining water-vapor-permeability in the thermally bonded area, with an adhesive softening temperatur lying in the second softening temperatur range. A material choice is then made so that the conditions according to the invention with respect to melting points and softening temperatur ranges for the two fiber components and fiber parts are satisfied and a temperature is chosen for thermal bonding that represents an adhesive softening temperatur for the second fiber part or the second fiber component at which softening of this fiber part or the second fiber component occurs, in which case its material exerts an adhesive effect, so that at least part of the fibers of the second fiber component are thermally bonded to each other by gluing, so that bonding stabilization of the fiber composite occurs that is above the bonding obtained in a fiber composite with the same materials for both fiber components by purely mechanical bonding, for example, by needle attachment of the fiber composite.

A embodiment for the second fiber component with two fiber parts of different melting points or different softening temperatur ranges has fibers with a core-shell structure in which the core has a higher melting point and a higher softening temperatur range than the shell and thermal bonding of the fiber component occurs by appropriate softening of the shell.

Another embodiment for the second fiber component with two fiber parts of different melting point or different softening temperatur ranges has fibers with a side-to-side structure, in which the second fiber component has two fiber parts running parallel to each other in the longitudinal direction of the fibers, a first one of which has a higher melting point and a higher softening temperatur range than the second fiber part, and thermal attachment of the fiber composite occurs by appropriate softening of the second fiber part.

In this embodiment, the adhesive softening temperatur can also be chosen in such a way that softening of the second fiber part of the second fiber component occurs to such an extent that not only are the second fiber parts of the second fiber component bonded to each other, but additionally partial or full enclosure of individual sites of the fibers of the first fiber component with softened material of the second fiber part of the second fiber component, i.e., partial or full embedding of those sites of fibers of the first fiber component in material of the second fiber part of the second fiber component, occurs, so that a correspondingly increased stabilization bonding of the fiber composite develops. This is especially true for the case in which the second fiber component has the already mentioned side-to-side fiber structure. During adhesive softening of the second fiber part of the second fiber component to the mentioned extent, partial or full enclosure, not only of individual sites of fibers of the first fiber component, but also of the first fiber part of the second fiber component, can then occur.

By additional compression of the fiber composite during or after adhesive softening of the second fiber component, an additional increase in stabilization can be achieved, in which partial or full embedding of fiber sites in softened material of fibers of the second fiber component is further intensified. The thermal bonding of the fiber composite, achieved by using the adhesive softening temperatur, is to be chosen, on the other hand, in such a way that sufficient water-vapor permeability of the fiber composite is produced, i.e., fiber bonding is always restricted to the individual bonding sites, so that sufficient unbonded sites for water-vapor transport remain. The choice of adhesive softening temperatur can be made according to the desired requirements of the practical embodiment, especially with respect to stability properties and water-vapor permeability.

By selecting specific materials for the two fiber components and by selecting the degree of thermal bonding of the fiber composite, a desired stabilization of the fiber composite with respect to its state before thermal bonding can be achieved while maintaining water-vapor permeability. Because of this thermal bonding, the fiber composite reaches a strength, based on which it is particularly suitable as a water-vapor-permeable barrier material that stabilizes a composite shoe sole and is therefore suitable for footwear whose shoe bottom is supposed to have good water-vapor-permeability, on the one hand, and good stability, on the other.

Because of its thermal bonding and the achieved stability, such a barrier material is particularly suited for a composite shoe sole that is designed to obtain high water-vapor permeability with large-area openings, so that it requires, on the one hand, a barrier material for protection of a membrane situated above it from penetration of foreign objects, such as pebbles, through such an opening to the membrane and, on the other hand, additional stabilization, because of the large-area openings.

Unlike a non-woven fiber composite traditionally used in the shoe-bottom area, which is constructed with a single fiber component that is completely melted and thermally compressed in the attempt at thermal bonding, in such a barrier material, by selecting the materials for the at least two fiber components and by the parameters chosen for thermal bonding, degrees of freedom can be utilized by means of which the degree of the desired stability, as well as the degree of water-vapor permeability, can be set. By softening the fiber component with the lower melting point, not only are the fibers of this fiber component fixed with respect to each other, but during the thermal bonding process, fixation of the fiber of the other fiber component with the higher melting point also occurs, which leads to particularly good mechanical bonding and stability of the fiber composite. By choosing the ratio between fibers of the fiber component with higher melting point and the fibers of the fiber component with the lower melting point, as well as by choosing the adhesive softening temperatur and therefore the degree of softening, properties of the barrier material, such as air permeability, water-vapor permeability, and mechanical stability of the barrier material, can be adjusted.

In one embodiment of the barrier material, its fiber composite is a textile fabric, which can be a woven, warp-knit, knit, non-woven fabric, felt, mesh, or lay. In one practical embodiment, the fiber composite is a mechanically strengthened non-woven fabric, whereby mechanical bonding can be achieved by needling the fiber composite. Water jet bonding can also be used for mechanical bonding of the fiber composite, in which, instead of true needles, water jets are used for mechanically bonding entanglement of the fibers of the fiber composite.

In one embodiment of the invention, the first fiber component is a support component and the second fiber component is a bonding component of the barrier material.

In one embodiment of the invention, in which the second fiber component has a first fiber part having a higher melting point and a second fiber part having a lower melting point, the first fiber part of the second fiber component forms an additional support component in addition to the first fiber component, the second fiber part of the second fiber component forming the bonding component of the barrier material.

The choice of materials for the fiber components is made in one embodiment in such a way that at least part of the second fiber component and then, if the second fiber component includes at least a first fiber part and a second fiber part, at least part of the second fiber part of the second fiber component can be activated at a temperature in the range between 80° C. and 230° C. for adhesive softening.

In one embodiment, the second softening temperatur range lies between 60° C. and 220° C.

Especially in view of the fact that footwear and especially its sole structure are often exposed to relatively high temperatures during production, for example, when an outsole is molded on, in one embodiment of the invention, the first fiber component, and optionally the first fiber part of the second fiber component, are melt-resistant at a temperature of at least 130° C., whereby, in practical embodiments, melt resistance at a temperature of at least 170° C. or even at least 250° C. is chosen by corresponding selection of the material for the first fiber part, and optionally for the first fiber part of the second fiber component.

For the first fiber part, and optionally the first fiber part and the second fiber component, materials such as natural fibers, plastic fibers, metal fibers, glass fibers, carbon fibers, and blends thereof, are appropriate. Leather fibers represent an appropriate material in the context of natural fibers.

In one embodiment of the invention, the second fiber component, and optionally the second fiber part of the second fiber component, are constructed with at least one synthetic fiber suitable for thermal bonding at an appropriate temperature.

In one embodiment of the invention, at least one of the two fiber components, and optionally at least one of the two fiber parts of the second fiber component, are chosen from the material group including polyolefins, polyamide, copolyamide, viscose, polyurethane, polyacrylic, polybutylene terephthalate, and blends thereof. The polyolefin can then be chosen from polyethylene and polypropylene.

In one embodiment of the invention, the first fiber component, and optionally the first fiber part of the second fiber component, is chosen from the material group polyesters and copolyesters.

In one embodiment of the invention, at least the second fiber component, and optionally at least the second fiber part of the second fiber component, are constructed with at least one thermoplastic material. The second fiber component, and optionally the second fiber part of the second fiber component, can be chosen from the material group polyamide, copolyamide, and polybutylene terephthalate and polyolefins, or also from the material group polyester and copolyester.

Examples of appropriate thermoplastic materials are polyethylene, polyamide (PA), polyester (PET), polyethylene (PE), polypropylene (PP), and polyvinylchloride (PVC). Additional appropriate materials are rubber, thermoplastic rubber (TR), and polyurethane (PU). Thermoplastic polyurethane (TPU), whose parameters (hardness, color, elasticity, etc.) can be adjusted very variably, is also suitable.

In one embodiment of the invention, both fiber parts of the second fiber component consist of polyester, the polyester of the second fiber part having a lower melting point than the polyester of the first fiber part.

In one embodiment of the invention, at least the second fiber component has a core-shell structure, i.e., a structure, in which a core material of the fiber component is coaxially surrounded by a shell layer. The first fiber part, having a higher melting point, then forms the core, and the second fiber part, having a lower melting point, forms the shell.

In another embodiment of the invention, at least the second fiber component has a side-to-side structure, i.e., two fiber parts of different material running next to each other in the longitudinal direction of the fiber, each of which have a semicircular cross-section, for example, are placed against each other, so that the two fiber components are joined to each other side by side. One side then forms the first fiber part of the barrier material, having a higher melting point, and the second side forms the second fiber part of the second fiber component of the barrier material, having a lower melting point.

In one embodiment of the invention, the second fiber component has a weight percentage, referred to the basis weight of the fiber composite in the range from 10% to 90%. In one embodiment, the weight percentage of the second fiber component lies in the range from 10% to 60%. In practical embodiments, the weight percentage of the second fiber component is 50% or 20%.

In one embodiment of the invention, the materials for the two fiber components, and optionally for the two fiber parts of the second fiber component, are chosen in such a way that their melting points differ by at least 20 C.°.

The barrier material can be thermally bonded over its entire thickness. Depending on the requirements to be achieved, especially with respect to air permeability, water-vapor permeability, and stability, an embodiment can be chosen in which only part of the thickness of the barrier material is thermally bonded. In one embodiment of the invention, the barrier material thermally bonded over at least part of its thickness is additionally compressed on at least one surface by means of pressure and temperature. It can be advantageous to smooth the bottom of the barrier material facing the tread of the composite shoe sole by surface compression, because dirt that reaches the bottom of the barrier material through openings of the composite shoe sole then adheres less readily to it. At the same time, the abrasion resistance of the barrier material is increased.

In one embodiment of the invention, the barrier material is finished or treated with one or more agents from the material group water repellants, dirt repellants, oil repellants, antibacterial agents, deodorants, and/or a combination thereof.

In another embodiment, the barrier material is treated so as to be water-repellant, dirt-repellant, oil-repellant, antibacterial and/or treated against odor.

In one embodiment of the invention, the barrier material has a water-vapor permeability of at least 4000 g/m^2-24 h. In practical embodiments, a water-vapor permeability of at least 7000 g/m^2-24 h or even 10,000 g/m^2-24 h is chosen.

In one embodiment of the invention, the barrier material is designed to be water-permeable.

In embodiments of the invention, the barrier material has a thickness in the range from at least 1 mm to 5 mm, whereby practical embodiments, especially in the range from 1 mm to 2.5 mm, or even in the range from 1 mm to 1.5 mm, are chosen, the specially selected thickness depending on the special application of the barrier material, and also on which surface smoothness, air permeability, water-vapor permeability, and mechanical strength are to be provided.

In a practical embodiment of the invention, the barrier material has a fiber composite with at least two fiber components that differ with respect to melting point and softening temperatur range, a first fiber component consisting of polyester and having a first melting point and a first softening temperatur range lying beneath it, and at least part of a second fiber component having a second melting point and a second softening temperatur range lying beneath it, whereby the first melting point and the first melting-point range are higher than the second melting point and the second melting-point range. The second fiber component has a core-shell structure and a first fiber part of polyester that forms the core and a second fiber part of polyester that forms the shell, the first fiber part having a higher melting point and a higher softening temperatur range than the second fiber part. The fiber composite, as a result of thermal activation of the second fiber component, is thermally bonded, while maintaining water-vapor permeability in the thermally bonded area, with an adhesive softening temperatur lying in the second softening temperatur range, and the fiber composite is a needled non-woven fabric that is compressed on at least one of its surfaces by means of pressure and temperature.

In one embodiment of the invention, the barrier material is obtained by surface compression of a surface of the fiber composite with a surface pressure in the range from 11.5 N/cm^2 to 4 N/cm^2 at a heating-plate temperature of 230° C. for 10 s. Ina practical embodiment, the surface compression of a surface of the fiber composite occurs with a surface pressure of 3.3 N/cm^2 at a heating-plate temperature of 230° C. for 10 s.

In one embodiment of the invention, the barrier material is produced with a puncture strength in the range from 290 N to 320 N, so that it forms a good protection for a waterproof, water-vapor-permeable membrane situated above it against penetration of foreign objects, such as small pebbles.

Such a barrier material is therefore particularly suited in a water-vapor-permeable composite shoe sole as a water-vapor-permeable barrier layer that stabilizes the composite shoe sole and protects the membrane situated above it.

A barrier unit constructed with such a barrier material is therefore particularly suited for a composite shoe sole according to the invention.

According to the invention, at least one stabilization device for stabilizing the barrier material and therefore the composite shoe sole is assigned to the barrier material. This is advantageous, especially when the barrier material itself is not designed or not adequately designed as a stabilization material, so that the barrier material acquires stabilization or stabilization support from the stabilization device. In this case, a situation is achieved in which additional stabilization is added to the intrinsic stability that the barrier material has, because of its thermal bonding, and optionally surface compression, which can be produced deliberately at certain sites of the barrier unit, especially in the area of openings of the composite shoe sole, which are made with a large surface, in order to provide high water-vapor-permeability of the composite shoe sole.

The forefoot area and midfoot area of the composite shoe sole will be discussed next. In the human foot, the forefoot is the longitudinal foot area extending over the toes and ball of the foot to the beginning of the instep, and the midfoot is the longitudinal foot area between the ball of the foot and the heel. In connection with the composite shoe sole according to the invention, forefoot area and midfoot area mean the longitudinal areas of the composite shoe sole over which the forefoot or the midfoot of the wearer of the footwear extends when wearing footwear provided with such a composite shoe sole.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that at least 15% of the surface of the forefoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 25% of the surface of the forefoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 40% of the surface of the forefoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 50% of the surface of the forefoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 60% of the surface of the forefoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 75% of the surface of the forefoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 15% of the surface of the midfoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 25% of the surface of the midfoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 40% of the surface of the midfoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 50% of the surface of the midfoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 60% of the surface of the midfoot area of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that 75% of the surface of the midfoot area of the composite shoe sole is water-vapor-permeable.

The stabilization devices of the midfoot area leading to the different percentages mentioned above can be combined with individual stabilization units of the forefoot area leading to the different percentages stated above.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that at least 15% of the front half of the longitudinal extent of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that at least 25% of the front half of the longitudinal extent of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such as way that at least 40% of the front half of the longitudinal extent of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that at least 50% of the front half of the longitudinal extent of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that at least 60% of the front half of the longitudinal extent of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that at least 75% of the front-half of the longitudinal extent of the composite shoe sole is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that of the longitudinal extent of the composite shoe sole minus the heel area, at least 15% is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that of the longitudinal extent of the composite shoe sole minus the heel area, at least 25% is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that of the longitudinal extent of the composite shoe sole minus the heel area, at least 40% is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that of the longitudinal extent of the composite shoe sole minus the heel area, at least 50% is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that of the longitudinal extent of the composite shoe sole minus the heel area, at least 60% is water-vapor-permeable.

In one embodiment of the invention, the at least one stabilization device is designed in such a way that of the longitudinal extent of the composite shoe sole minus the heel area, at least 75% is water-vapor-permeable.

The percentages just stated, in conjunction with water-vapor-permeability, refer to that part of the entire composite shoe sole that corresponds to the surface within the outside contour of the foot sole of the wearer of the footwear, i.e., essentially the surface part of the composite shoe sole that is enclosed in the finished footwear by the inner periphery of the lower shaft end on the sole side (shaft contour on the sole side). A shoe sole edge that protrudes radially outward above the shaft contour on the sole side, i.e., protrudes above the foot sole of the wearer of the footwear, need not have water-vapor permeability, because no sweat-releasing foot area is situated there. The percentages mentioned therefore refer, with respect to the forefoot area, to the part of the surface included by the shaft contour on the sole side bonded on the forefoot length and, with respect to the midfoot area, to the part of the surface enclosed by the shaft contour on the sole side bounded on the midfoot length.

If the footwear in question is a business shoe whose outsole has an outsole peripheral edge protruding relatively widely above the outside of the shaft contour on the sole side, which, for example, is firmly stitched on a mounting frame that also runs around the outside of the shaft contour on the sole side, water-vapor permeability need not exist in the area of this outsole peripheral edge, since this area is situated outside the part of the composite shoe sole contacted by the foot, and therefore no sweat release occurs in this area. The percentages mentioned in the preceding paragraphs refer to footwear that does not have the above-mentioned protruding outsole edge typical of business shoes. Since this outsole area of the business shoe can account for about 20% of the total outsole surface, about 20% can be subtracted in business shoes from the total outsole surface, and the above-mentioned percentages for water-vapor permeability of the composite shoe sole pertain to the remaining 80% of the total outsole surface.

The stabilization device can consist of one or more stabilization bars, which are arranged, for example, on the bottom of the barrier material on the outsole side. In one embodiment, the stabilization device is provided with at least one opening, which forms at least one part of the trough hole after production of the composite shoe sole and is closed with barrier material.

In one embodiment of the invention, the above-mentioned percentage water-vapor permeabilities in the forefoot area and/or midfoot area are provided mostly or even exclusively in the area of the at least one opening of the stabilization device.

In one embodiment of the invention, at least one support element is assigned to the barrier material in the trough hole or at least one of the trough holes, which extends from the side of the barrier material facing the tread to the level of the tread, so that the barrier material, during walking, is supported on the floor by the support element. In this case, at least one of the stabilization bars can simultaneously be designed as a support element.

In the composite shoe sole, which, according to the invention, has the barrier unit and a one-part or multipart outsole arranged beneath it, which has passage openings for water-vapor permeability, the passage openings of the outsole or outsole parts and the barrier unit can have the same or different surface areas. It is important that these passage openings overlap at least partially, whereby an intersection surface of the corresponding passage opening of the barrier unit and the corresponding passage opening of the outsole or the outsole part forms an opening through the entire composite shoe sole. When a specific dimension of the corresponding passage opening of the outsole or outsole part is stipulated, the extent of the opening is greatest when the corresponding passage opening of the barrier unit is at least equally large and extends over the entire area of the corresponding passage opening of the outsole or outsole part, or vice versa.

It is proposed that the stabilization device, with the at least one stabilization bar, not be a component of the at least one outsole part. This means that the stabilization device, and especially the at least one stabilization bar, does not assume an outsole function. In particular, a stabilization device with the at least one stabilization bar has a spacing from the floor or substrate. The composite shoe sole with outsole is prescribed for walking and standing on a floor or on the ground. In this case, the at least one stabilization bar in the composite shoe sole is situated above the floor or ground and a certain distance is prescribed between the stabilization bar and the floor. In one embodiment, the distance corresponds to the thickness of the at least one outsole part, which is arranged beneath the barrier unit.

An exception from the stipulation that the at least one stabilization bar has a spacing from the floor or the ground applies when a stabilization bar is simultaneously formed as a support element that extends to the floor or ground.

In another embodiment, it is prescribed that the outsole part has a first material and the stabilization device has a second material that is different from the first material, the second material being harder (according to Shore) than the first material. "Hardness" is understood to mean the mechanical resistance that a substance has in order to withstand the penetration of another, harder substance.

Due to the fact that the corresponding opening of the composite shoe sole is closed with a water-vapor-permeable barrier material, water-vapor permeability in the at least one opening of the composite shoe sole is achieved with simultaneous protection of a membrane situated above it against the penetration of foreign objects, such as pebbles. If a barrier material is used for the barrier unit that can be equipped with a much higher intrinsic stability, as a result of thermal bonding and optionally additional surface compression, than the material can offer without thermal bonding and surface bonding, such a barrier material for the barrier unit can offer additional stabilization to the composite shoe sole provided with openings, even if the one or more openings of the composite shoe sole are designed with a very large area in the interest of high water-vapor-permeability. This intrinsic stability is further increased by the use of the already mentioned additional stabilization device and selectively in areas of the composite shoe sole that require special stabilization.

If the stabilization device is provided with several openings, these can either be closed overall with a piece of the barrier material or each with a piece of barrier material.

The stabilization device can be designed to be sole-shaped, if it is to extend over the entire area of the composite shoe sole, or partially sole-shaped, if it is to be provided only in part of the surface of the composite shoe sole.

In one embodiment of the invention, the stabilization device of the barrier unit has at least one stabilization frame that stabilizes at least the composite shoe sole, so that the composite shoe sole experiences an additional stabilization apart from the stabilizing effect through the barrier material. A particularly good stabilization effect is achieved if the stabilization frame is fit into the at least one opening, or at least one of the openings of the composite shoe sole, so that where the composite shoe sole is initially weakened in its stability by the openings with the largest possible area, good stabilization of the composite shoe sole is nevertheless ensured by means of the stabilization frame.

In one embodiment of the barrier unit according to the invention, the at least one opening of the stabilization device has an area of at least 1 cm^2. In practical embodiments, an opening surface with at least one opening of at least 5 cm^2, for example, in the range from 8 to 15 cm^2, or even at least 10 cm^2, or even at least 20 cm^2, or even at least 40 cm^2, is chosen.

In the barrier unit according to the invention, the stabilization device has at least one stabilization bar that is arranged on at least one surface of the barrier material and at least partially bridges the surface of the at least one opening. If the stabilization device is provided with a stabilization frame, a stabilization bar can be arranged on the stabilization frame. Several stabilization bars can be provided that form a mesh-like structure on at least one surface of the barrier material. Such a mesh structure leads to particularly good stabilization of the composite shoe sole, on the one hand, and also prevents larger foreign objects, such as larger stones or ground elevations, from penetrating up to the barrier material and being felt by the user of the footwear equipped with such a barrier unit.

In one embodiment, the stabilization device of the barrier unit of the composite shoe sole according to the invention is constructed with at least one thermoplastic material. Thermoplastic materials of the above-mentioned type can be used for this.

In one embodiment of the invention, the stabilization device and the barrier material are at least partially connected to each other, for example, by gluing, welding, molding on or around, or vulcanization on or around. During molding or vulcanization on, mostly attaching between the stabilization device and the barrier material occurs on opposite surface areas. During molding and vulcanization around, mostly peripheral incorporation of the barrier material with the stabilization device occurs.

In one embodiment, the composite shoe sole is water-permeable.

According to a second aspect, the invention makes available footwear with a composite shoe sole according to the invention that can be constructed according to one or more of the embodiments mentioned above in conjunction with the composite shoe sole. The footwear then has a shaft provided on a shaft-end area on the sole side with a waterproof and water-vapor-permeable shaft-bottom functional layer, whereby the composite shoe sole is connected to the shaft-end area provided with the shaft-bottom functional layer, so that the shaft-bottom functional layer, at least in the area of at least one opening of the composite shoe sole, is not joined to the barrier material.

The shaft-bottom functional layer in this footwear according to the invention, on the shaft-end area on the sole side and the barrier material in the composite shoe sole according to the invention, leads to several advantages. On the one hand, handling of the shaft-bottom functional layer is brought into the area of shaft production and kept out of the area of production of the composite shoe sole. This takes into account the practice that shaft manufacturers and composite-sole manufactures are often different manufacturers or at least different manufacturing areas, and the shaft manufacturer is usually better set up to handle the functional layer material and its intrinsic problems than shoe-sole manufacturers or composite-shoe-sole manufacturers. On the other hand, the shaft-bottom functional layer and the barrier material, if they are not accommodated in the composite itself, but are divided to the shaft-bottom composite and the shoe-sole composite, after attachment of the composite shoe sole to the lower shaft-end area, can be kept essentially unconnected to each other, since their positioning with respect to each other in the finished footwear is brought about by attachment (by gluing on or molding on) of the composite shoe sole onto the lower shaft end. Keeping the shaft-bottom functional layer and the attaching material fully or largely unbonded to each other means that there need be no gluing between them, which would lead to blocking of part of the active area of the functional layer with water-vapor permeability, even during gluing with a spot-like glue.

In one embodiment of the footwear according to the invention, the shaft is constructed with at least one shaft material that has a waterproof shaft functional layer, at least in the area of the shaft-end area on the sole side, whereby, between the shaft functional layer and the shaft-bottom functional layer, a waterproof seal exists. Footwear is then achieved in which the foot[wear] is waterproof, both in the shaft area and in the shaft-bottom area, and at the transition sites between the two, while maintaining water-vapor permeability both in the shaft and shaft-bottom area.

In one embodiment of the footwear according to the invention, the shaft-bottom functional layer is assigned to a water-vapor-permeable shaft-mounting sole, whereby the shaft-bottom functional layer can be part of a multilayer laminate. The shaft-mounting sole can itself also be formed by the shaft-bottom functional layer constructed with the laminate. The shaft-bottom functional layer, and optionally the shaft functional layer, can be formed by a waterproof, water-vapor-permeable coating or by a waterproof, water-vapor-permeable membrane, whereby either a microporous membrane or a membrane having no pores can be involved. In one embodiment of the invention, the membrane has expanded polytetrafluoroethylene (ePTFE).

Appropriate materials for the waterproof, water-vapor-permeable functional layer are polyurethane, polypropylene, and polyester, including polyether esters and laminates thereof, as described in documents U.S. Pat. No. 4,725,418 and U.S. Pat. No. 4,493,870. However, expanded microporous polytetrafluoroethylene (ePTFE) is particularly preferred, as described, for example, in documents U.S. Pat. No. 3,953,566 and U.S. Pat. No. 4,187,390, and expanded polytetrafluoroethylene provided with hydrophilic impregnation agents and/or hydrophilic layers; see, for example, document U.S. Pat. No. 4,194,041. "Microporous functional layer" is understood to mean a functional layer whose average pore size is between about 0.2 μm and about 0.3 μm. The pore size can be measured with the Coulter Porometer (trade name), which is produced by Coulter Electronics Inc., Hialeah, Fla., USA.

According to a third aspect, the invention makes available a method for producing footwear, which, in addition to a water-vapor-permeable composite shoe sole according to the invention, for example, according to one or more of the embodiments mentioned above for the composite shoe sole, has a shaft provided on a shaft-end area on the sole side with a waterproof and water-vapor-permeable shaft-bottom functional layer. In this method, the composite shoe sole and the shaft are prepared first. The shaft is provided on the shaft-end area on the sole side with a waterproof and water-vapor-permeable shaft-bottom functional layer. The composite shoe sole and the shaft end area provided on the sole side with the shaft-bottom functional layer are joined to each other, so that the shaft-bottom functional layer remains unconnected to the barrier material, at least in the area of the at least one opening. This leads to the advantages already explained above.

In one embodiment of this method, the shaft-end area on the sole side is closed with the shaft-bottom functional layer. For the case in which the shaft is provided with a shaft functional layer, a waterproof connection is produced between the shaft functional layer and the shaft-bottom functional layer. This leads to footwear that is waterproof and water-vapor-permeable footwear overall.

The invention, task aspects of the invention, and advantages of the invention will now be further explained with reference to embodiments. In the corresponding drawings:

FIG. **1**

shows a sketch of a non-woven material, mechanically bonded by needling;

FIG. **2**

also shows a sketch of the non-woven material according to FIG. **1**, after thermal bonding;

FIG. **2***a*

shows a cutout, also as a sketch, at a highly enlarged scale of area IIa of the thermally bonded non-woven material of FIG. **2**.

FIG. **2***b*

shows a cutout, also in a sketch, with an even more enlarged scale of area IIa, shown in FIG. **2**, of the thermally bonded non-woven material of FIG. **2**.

FIG. **3**

shows a sketch of the thermally bonded non-woven material depicted in FIG. **2** after additional thermal surface compression;

FIG. **4**

shows a schematic view of a composite shoe sole, still without barrier material, showing the opening extending through the thickness of the composite shoe sole.

FIG. **5**

shows a schematic view of a first example of a barrier unit with a stabilization device having a bar and a barrier material accommodated in it.

FIG. **6**

shows a schematic view of another example of a barrier unit with a stabilization device having a bar and a barrier material.

FIG. **7**

shows a schematic view of additional examples of a barrier unit with a stabilization device in the form of at least one bar.

FIG. **8**

shows a schematic view of another example of a barrier unit with a stabilization device having a bar and a barrier material.

FIG. **9**

shows a schematic view of the composite shoe sole depicted in FIG. **4** with barrier material and a stabilization device, having a bar.

FIG. **10**

shows a schematic view of stabilization bars arranged on the bottom of the barrier material.

FIG. **11**

Shows a schematic view of a stabilization mesh arranged on the bottom of the barrier material.

FIG. **12**

shows a perspective oblique view from the bottom of a shoe provided with a composite sole according to the invention.

FIG. **13***a*

shows the shoe depicted in FIG. **12**, but before a composite shoe sole according to the invention is placed on a shaft bottom of the shoe.

FIG. **13***b*

shows the shoe depicted in FIG. **12**, which is provided with another example of a composite sole according to the invention.

FIG. **14**

shows the composite shoe sole depicted in FIG. **13***a*, in a perspective top view.

FIG. **15**

shows the composite shoe sole depicted in FIG. **14** in an exploded view of its individual components, in an oblique perspective view from the top.

FIG. **16**

shows the part of the composite shoe sole depicted in FIG. **15**, in a perspective oblique view from the bottom.

FIG. **17**

shows a forefoot area and a midfoot area of the barrier unit depicted in FIG. **16**, in a perspective oblique view from the top, whereby the stabilization device parts and the barrier material parts are shown separately from each other.

FIG. **18**

shows, in a perspective oblique view from the bottom, a modification of the midfoot area of the barrier unit depicted in FIG. **17**, whereby only a middle area of this barrier=unit part is occupied with barrier material and two side parts are formed without passage openings.

FIG. **19**

shows the barrier unit part depicted in FIG. **18**, in a view in which the corresponding stabilization-device part and the corresponding barrier-material part are shown separately from each other.

FIG. **20**

shows a schematic sectional view in the forefoot area through a shaft closed on the shaft-bottom side of a first embodiment, with a composite shoe sole still not positioned on the shaft bottom.

FIG. **21**

shows a schematic view of another example of the barrier unit with a barrier material and a stabilization bar during selected bonding with a shaft bottom situated above it.

FIG. **22**

shows a detail view of the shoe structure depicted in FIG. **20**, with a glued-on composite shoe sole.

FIG. **23**

shows a detail view of the sole structure depicted in FIG. **21**, with a molded-on composite shoe sole.

FIG. **24**

shows a shoe structure similar to that shown in FIG. **20**, but with a differently constructed shaft bottom, with a composite shoe sole still separated from the shaft.

FIG. **25**

shows a detail view of the shoe structure depicted in FIG. **24**.

FIG. **26**

shows a composite sole in another embodiment.

FIG. **27**

Shows a composite shoe sole in another embodiment.

An embodiment of a barrier material particularly suited for a composite shoe sole according to the invention will be initially explained first reference to FIGS. **1** through **3**. Explanations concerning embodiments of a barrier unit according to the invention then follow, with reference to FIGS. **4** through **11**. Embodiments of the footwear according to the invention and composite shoe soles according to the invention will then be explained by means of FIGS. **12** through **27**.

The embodiment of the barrier material depicted in FIGS. **1** through **3** consist of a fiber composite **1** in the form of a thermally bonded and thermally surface-bonded non-woven material. This fiber composite **1** consists of two fiber components **2**, **3**, which are each constructed with polyester fibers. A first fiber component **2**, which serves as support component of the fiber composite **1**, then has a higher melting point than that of the second fiber component **3**, which serves as bonding component. In order to guarantee temperature stability of the entire fiber composite **1** of at least 180° C., specifically in view of the fact that footwear can be exposed to relatively high temperatures during production, for example, during molding-on of an outsole, in the embodiment in question, polyester fibers with a melting point above 180° C. were used for both fiber components. There are different variations of polyester polymers that have different melting points and softening temperaturs below them. In the embodiment in question of the barrier material according to the invention, a polyester polymer with a melting point of about 230° C. was chosen for the first component, whereas a polyester polymer with a melting point of about 200° C. is chosen for at least one fiber part of the second fiber component **3**. In one embodiment, in which the second fiber component has two fiber parts in the form of a core-shell fiber structure, the core **4** consists of this fiber component from polyester with a softening temperatur of about 230° C. and the shell of this fiber component consists of a polyester with an adhesive softening temperatur of about 200° C. (FIG. **2***b*). Such a fiber component with two fiber parts of different melting points is also referred to as "bico," for short. This concise term will be used subsequently.

In the embodiment in question, the fibers of the two fiber components are both stable fibers with the above-mentioned special properties. With respect to the total basis weight of the fiber composite of about 400 g/m^2, the weight fraction of the first fiber component is about 50%. The weight fraction of the second fiber component is also about 50% with respect to the basis weight of the fiber composite. The fineness of the first fiber component is 6.7 dtex, whereas the second fiber component, designed as a bico, has a higher fineness of 4.4 dtex.

To produce such barrier materials, the fiber components present as staple fibers are first mixed. Several individual layers of this staple fiber mixture are then placed one on top of the other in the form of several individual non-woven layers, until the basis weight sought for the fiber component is reached, in which case a non-woven package is obtained. This non-woven package has only very slight mechanical stability and must therefore pass through a strengthening process.

Initially, mechanical strengthening of the non-woven package occurs by needling by means of a needle technique in which needle bars arranged in a needle matrix penetrate the non-woven package perpendicular to the plane of extension of the non-woven package. Fibers of the non-woven package are reoriented by this from their original position in the non-woven package, so that balling of the fibers and a more stable mechanical structure of the non-woven package occur. A non-woven material mechanically strengthened by such needling is schematically shown in FIG. **1**.

The thickness of the non-woven package with respect to the initial thickness of the unneedled non-woven package is already reduced by the needling process. However, this structure obtained by needling is still not permanently tenable, since it is a purely mechanical three-dimensional "hooking" of stable fibers, which can be "unhooked" again under stress.

In order to achieve permanent stabilization, namely a stabilizing property for the use in footwear, the fiber composite is further treated according to the invention. Thermal energy and pressure are then used. In this process, the advantageous composition of the fiber mixture is utilized, in which a temperature is chosen for thermal bonding of the fiber mixture, so that it lies at least in the range of the adhesive softening temperatur of the shell of the core-shell bico that melts at a lower melting point, in order to soften it into a viscous state, so that the fiber parts of the first fiber component, which is situated in the vicinity of the softened mass of the shell of the corresponding bico, can be partially incorporated in this viscous mass. Because of this, the two fiber components are permanently bonded to each other without changing the fundamental structure of the non-woven material. The advantageous properties of this non-woven material can also be utilized, especially its good water-vapor permeability combined with a permanent mechanical-stabilization property.

Such a thermally bonded non-woven material is shown schematically in FIG. **2**, in which a detailed view of a cutout on a highly enlarged scale is shown in FIG. **2***a*, in which the glue-bonding points between individual fibers are shown by flat black spots, and FIG. **2***b* shows an area of the cutout on an even larger scale.

In addition to thermal bonding of the non-woven material, thermal surface compression can be performed on at least one surface of the non-woven material by exposing the surface of this non-woven material simultaneously to the effect of pressure and temperature, for example, by means of heating compression plates or compression rollers. The result is even stronger bonding than in the remaining volume of the non-woven material and smoothing of the thermally compressed surface.

A non-woven material initially mechanically bonded by needling, then thermally bonded, and finally thermally surface-compressed on one of its surfaces, is shown schematically in FIG. **3**.

In an accompanying comparison table, various materials, including barrier materials according to the invention, are compared with respect to some parameters. Split sole leather, two non-woven materials only needle-bonded, a needle-bonded and thermally bonded non-woven material, and, finally, a needle-bonded, thermally bonded, and thermally surface-compressed non-woven material are then considered, whereby these materials, for simplicity of the subsequent treatment of the comparison table, are assigned the material numbers 1 to 5 in the comparison table.

The longitudinal elongation values and the transverse elongation values show the percentage by which the corresponding material expands when acted upon with a stretching force of 50 N, 100 N, or 150 N. The lower the longitudinal and transverse elongation, the more stable and better suited as a barrier material the material is. If the corresponding material is used as a barrier material to protect the membrane against penetration of foreign objects, such as pebbles, puncture resistance is important. The abrasion strength, called abrasion in the comparison table, is also significant for use of the corresponding material in a composite shoe sole.

It can be seen from the comparison table that split sole leather does have high tensile strength, relatively good resistance to stretching forces, and high puncture resistance, but it only has moderate abrasion strength during wet tests, and especially quite moderate water-vapor permeability.

The only needle-bonded non-woven materials (material 2 and material 3) are relatively light and have high water-vapor permeability in comparison with leather, but they have relatively low stretching resistance in terms of stretching forces, possess only limited puncture resistance, and have only moderate abrasion strength.

The needle-bonded and thermally bonded non-woven material (material 4), at a lower thickness, has a higher basis weight than materials 2 and 3, and is therefore more compact. The water-vapor permeability of material 4 is higher than that of material 2 and about as high as that of material 3, but almost three times as high as that of leather according to material 1. The longitudinal and transverse elongation resistances of material 4 are much higher than those of non-woven materials 2 and 3, which are only needle-bonded and the longitudinal and transverse breaking load is also much higher than that of materials 2 and 3. The puncture resistance and abrasion strength in material 4 are also much higher than in materials 2 and 3.

Material 5, i.e., the needle-bonded, thermally bonded, and non-woven material thermally compressed on one of its surfaces, has a lower thickness than material 4, because of thermal surface compression with the same basis weight, and therefore takes up less room in a composite shoe sole. The water-vapor permeability of material 5 still lies above that of material 4. With respect to elongation resistance, material 5 is also superior to material 4, since it shows no elongation when longitudinal and transverse elongation forces of 50 N to 150 N are applied. The tensile strength is higher with respect to longitudinal loading and lower with respect to transverse loading than that of material 4. The puncture resistance is somewhat below that of material 4, which is caused by the more limited thickness of material 5. A special superiority compared to all materials 1 to 4 is exhibited by material 5 with respect to abrasion strength.

The comparison table therefore shows that when high water-vapor permeability, high shape stability, and therefore a stabilization effect and a high abrasion resistance are required in the material, material 4, and especially material 5, are quite particularly suited.

In the case of material 5, the needle-bonded and thermally bonded non-woven material, which also has very good stabilization, in one embodiment of the invention is then subjected to hydrophobic finishing, for example, by a dipping process in a liquid that causes hydrophobization, in order to minimize suction effects of the non-woven material. After the hydrophobization bath, the non-woven material is dried under the influence of heat, whereby the hydrophobic property of the applied finishing is further improved. After the drying process, the non-woven material passes through sizing rollers, whereby the final thickness of, say, 1.5 mm is also set.

In order to achieve a particularly smooth surface, the non-woven material is then exposed to temperature and pressure again, in order to melt the fiber parts, namely the second fiber component in the shell of the bico on the surface of the non-woven material and to press it against a very smooth surface by means of pressure applied simultaneously. This occurs either with appropriate calendering devices or by means of a heated compression die, whereby a separation material layer can be introduced between the non-woven and material the heated pressure plate, which can be silicone paper or Teflon, for example. Surface smoothing by thermal surface compression is performed on only one surface or both surfaces of the non-woven material, depending on the desired properties of the barrier material.

As already shown by the comparison table, the non-woven material thus produced has high stability against a tearing load and possesses good puncture resistance, which is important when the material is used as a barrier material to protect a membrane.

Material 5, just described, represents a first example embodiment of the barrier material used according to the invention, in which both fiber components consist of polyester, both fiber components have a weight percentage of 50% in the total fiber composite, and the second fiber component is a polyester core-shell fiber of the bico type.

Additional example embodiments of the barrier material used according to the invention will now be considered briefly:

EXAMPLE EMBODIMENT 2

A barrier material, in which both fiber components consist of polyester and have a weight percentage of 50% each in the total fiber composite, and the second fiber component is a bico from polyester of the side-by-side type.

Except for the special bico structure, the barrier material according to example embodiment 2 is produced in the same way and has the same properties as the barrier material according to example embodiment 1 with a bico fiber of the core-shell type.

EXAMPLE EMBODIMENT 3

A barrier material, in which both fiber components have a weight percentage of 50% and the first fiber component is a polyester and the second fiber component is a polypropylene.

In this example embodiment, no bico is used, but a single-component fiber is instead used as the second fiber component. For production of this fiber composite, only two fiber components with different melting points are chosen. In this case, the polyester fiber (with a melting point of about 230° C.) with a weight fraction of 50% represents the support component, whereas the polypropylene fiber, also with a weight fraction of 50%, has a lower melting point of about 130° C. and therefore represents the gluable bonding component. The production process otherwise runs as in example embodiment 1. In comparison to example embodiment 2, the non-woven material according to example embodiment 3 has lower heat stability, but it can also be produced using lower temperatures.

EXAMPLE EMBODIMENT 4

A barrier material with a percentage of 80% polyester as the first fiber component and a polyester core-shell bico as the second fiber component.

In this example embodiment, production again occurs as in example embodiment 1, the only difference being that the percentage of the second fiber component, which forms the bonding component, is changed. Its weight percentage is now only 20% compared to 80% of the weight formed by the first fiber component, which has a higher melting point. Because of the proportionate reduction in the bonding component, the stabilizing effect of the barrier material obtained is reduced. This can be advantageous when a non-woven material with high mechanical lifetime combined with increased flexibility is required. The temperature resistance of this non-woven material corresponds to that of the first example embodiment.

Some example embodiments of a composite shoe sole and a barrier unit and details of it are now considered by means of FIGS. **4** through **11**.

FIG. **4** shows a partial cross-section through a composite shoe sole **21** with an underlying outsole **23** and a shoe stabilization device **25** situated above it, before this composite shoe sole **21** is provided with a barrier material. The outsole **23** and the shoe-stabilization device **25** each have openings **27** and **29**, which together form a passage **31** through the total thickness of the composite shoe sole **21**. The passage **31** is therefore formed by the intersection surface of the two passage openings **27**, **29**. To complete this composite shoe sole **21**, a barrier material **33** (not shown in FIG. **4**) is placed in the passage opening **29** or arranged above it.

FIG. **5** shows an example of a barrier unit **35** with a piece of barrier material **33** held by a stabilization device **25**.

In one embodiment, the stabilization device is molded around the peripheral area of the piece of barrier material **33** or molded onto it, so that the material of the stabilization device **25** penetrates into the fiber structure of the barrier material **33** and is cured there and forms a solid composite.

As a material for molding of the stabilization device or molding onto the stabilization device, thermoplastic polyurethane (TPU) is suitable, which leads to very good enclosure of the barrier material and can be well bonded to it.

In another embodiment, the barrier material **33** is glued to the stabilization device **25**. The stabilization device **25** preferably has a stabilization frame that stabilizes at least the composite show sole **21** and at least one stabilization bar **37**, which is arranged on a surface of the barrier material **33**. The at least one stabilization bar **37** is preferably arranged on the bottom of the barrier material **33** facing the outsole.

FIG. **6** shows a barrier unit **35**, in which a piece of barrier material **33** is enclosed by a stabilization device **25** in the sense that the edge area of the barrier material **33** is not only surrounded by the stabilization device **25**, but also held on both surfaces.

FIG. **7** shows a barrier unit **35**, in which a piece of barrier material **33** is provided with a stabilization device **25** in the form of at least one stabilization bar **37**. The stabilization bar **37** is arranged on at least one surface of the barrier material **33**, preferably on the surface facing downward toward the outsole **23**.

FIG. **8** shows a barrier unit **35**, in which a piece of barrier material **33** is provided with a stabilization device **25**, so that the barrier material **33** is applied to at least one surface of the stabilization device **25**. The barrier material **33** then covers the passage opening **29**. The stabilization bar **37** is situated within the passage opening **29** of the stabilization device **25**.

FIG. **9** shows a composite shoe sole **21** according to FIG. **4**, which has a barrier unit according to FIG. **5** above the outsole **23**, whereby only one stabilization bar **37** is shown.

For all the embodiments according to FIGS. **4** to **9** described above, it is true that the bonding material during molding on, molding around, or gluing between the barrier material **33** and the stabilization device **25**, not only adheres to the surfaces being joined, but also penetrates into the fiber structure and cures there. The fiber structure is therefore additionally strengthened in its joining area.

Two embodiments of stabilization-bar patterns of stabilization bars **37** applied to a surface of the barrier material **33** are shown in FIGS. **10** and **11**. Whereas, in the case of FIG. **10**, three individual bars **37***a*, **37***b*, and **37***c* are arranged in a T-shaped mutual arrangement on a circular surface **43**, for example, the bottom of barrier material **33**, which corresponds to a trough hole of the composite shoe sole **21**, for example, by gluing onto the bottom of the barrier material, in the case of FIG. **11**, a stabilization-bar device in the form of a stabilization mesh **37***d* is provided.

Embodiments of shoes designed according to the invention will now explained with reference to FIGS. **12** through **27**, whereby their individual components will also be considered, especially in connection with the corresponding composite shoe sole.

FIG. **12** shows, in a perspective oblique view from the bottom, an example embodiment of a shoe **101** according to the invention with a shaft **103** and a composite shoe sole **105** according to the invention. The shoe **101** has a forefoot area **107**, a midfoot area **109**, a heel area **111**, and a foot-insertion opening **113**. The composite shoe sole **105** has a multipart outsole **117** on its bottom, which has an outsole part **117***a* in the heel area, an outsole part **117***b* in the area of the ball of the foot, and an outsole part **117***c* in the toe area of the composite shoe sole **105**. These outsole parts **117** are attached to the bottom of a stabilization device **119**, which has a heel area **119***a*, a midfoot area **119***b*, and a forefoot area **119***c*. The composite shoe sole **105** will be further explained in detail with reference to the following diagrams.

Additional components of the composite shoe sole **105** can be damping sole parts **121***a* and **121***b*, which are applied in the heel area **111** and in the forefoot area **107** on the top of the stabilization device **119**. The outsole **117** and the stabilization device **119** have passage openings that form trough holes through the composite shoe sole. These trough holes are covered by barrier materials **33***a*-**33***d* in a water-vapor-permeable manner. FIG. **13***a* shows the shoe **101** according to FIG. **12** in a manufacturing stage in which the shaft **103** and the composite shoe sole **105** are still separate from each other. The shaft **103** is provided on its lower end area on the sole side with a shaft bottom **221**, which has a waterproof, water-vapor-permeable shaft-bottom functional layer, which can be a waterproof, water-vapor-permeable membrane. The functional layer is preferably a component of a multilayer functional-layer laminate that has at least one protective layer, for example, a textile backing, as processing protection, in addition to the functional layer. The shaft bottom **115** can also be provided with a shaft-mounting sole. However, there is also the possibility of assigning the function of shaft-mounting sole to the functional-layer laminate. The composite shoe sole also has the trough holes **31** already mentioned in FIG. **8**, which are covered with barrier-material parts **33***a*-**33***d*. The bars **37** are shown within the peripheral edge of the corresponding trough holes. In other embodiments, three trough holes, two trough holes, one trough hole can be provided. In another embodiment, more than four trough holes are provided. The composite shoe sole **105** can be attached to the shaft end on the sole side, either by molding on or gluing, in order to produce the state according to FIG. **12**. For a detailed explanation of the functional layer and its laminate and the connection with the mounting sole, refer to the description and FIGS. **20** to **25** are referred to.

FIG. **13***b* shows the same shoe structure as in FIG. **13***a*, with the difference that the shoe in FIG. **13***a* has four trough holes **31**, whereas the shoe according to FIG. **13***b*, is provided with two trough holes **31**. It can be seen here that the bars **37** are arranged within the peripheral edge of the corresponding trough hole **31** and do not form a limitation of the trough hole **31**. The surface of a trough hole is determined minus the total surface of the bars bridging it, since this bar surface blocks water-vapor transport.

FIG. **14** shows a composite shoe sole **105** with a top lying away from the outsole **117**. On the top lying away from the outsole **117**, the stabilization device **119** is covered in its middle area **119***b* and its forefoot area **119***c* with several pieces **33***a*, **33***b*, **33***c*, and **33***d* of a barrier material **33**, with which trough holes of the composite shoe sole **105** (not visible in FIG. **14**) are covered. In the heel area and in the forefoot area of the composite shoe sole **105**, a damping sole part **121***a* and **121***b* is applied to the top of the stabilization device **119**, essentially over the entire surface in the heel area and with recesses in the forefoot area wherever the barrier material parts **33***b*, **33***c* and **33***d* are situated.

Since the outsole parts of outsole **117**, the stabilization device **119**, and the damping sole parts **121***a* and **121***b* have different functions within the composite shoe sole, they are appropriately also constructed with different materials. The outsole parts, which are supposed to have good abrasion resistance, consist, for example, of a thermoplastic polyurethane (TPU) or rubber. Thermoplastic polyurethane is the term for a number of different polyurethanes that can have various properties. For an outsole, a thermoplastic polyurethane can be chosen with high stability and slip resistance. The damping sole parts **121***a* and **121***b*, which are supposed to produce shock absorption during walking movements of the user of the shoe, consist of correspondingly elastically compliant material, for example, ethylene-vinyl acetate (EVA) or polyurethane (PU). The stabilization device **119**, which serves as a holder for the non-coherent outsole parts **117***a*, **117***b*, **117***c* and for the also non-coherent damping sole parts **121***a*, **121***b* and serves as a stabilization element for the entire composite shoe sole **105** and is supposed to have corresponding elastic rigidity, consists of at least one thermoplastic material. Examples of appropriate thermoplastic materials are polyethylene, polyamide, polyamide (PA), polyester (PET), polyethylene (PE), polypropylene (PP), and polyvinylchloride (PVC). Other appropriate materials are rubber, thermoplastic rubber (TR), and polyurethane (PU). Thermoplastic polyurethane (TPU) is also suitable.

The composite shoe sole depicted in FIG. **14** is shown in an exploded view in FIG. **15**, i.e., in a view in which the individual parts of the composite shoe sole **105** are shown separately from each other, except for the barrier material parts **33***a*, **33***b*, **33***c*, and **33***d*, which are already shown arranged on the stabilization device parts **119***b* and **119***c*. In the embodiment depicted in FIG. **15**, the stabilization device **119** has its parts **119***a*, **119***b*, and **119***c* as initially separate parts, which are joined together to the stabilization device **119** during assembly of the composite shoe sole **105**, which can occur by welding or gluing of the three stabilization device parts to one another. As will still be explained in connection with FIG. **16**, openings are situated beneath the barrier material parts, which, together with openings **123***a*, **123***b*, and **123***c* in the outsole parts **117***a*, **117***b*, and **117***c*, form trough holes **30** of the type already explained in connection with FIG. **4**, and with which barrier material parts **33***a*-**33***d* are covered in a water-vapor-permeable manner. A passage opening **125** in the heel part **119***a* of the stabilization device **119** is not closed with barrier material **33**, but with the full-surface damping sole part **121***a*. A better damping effect of the composite shoe sole **105** in the heel area of the shoe is thereby achieved, where sweat-moisture removal, under some circumstances, can be less required, since foot sweat mostly forms in the forefoot and midfoot areas, but not in the heel area.

The damping sole part **121***b* is provided with passage openings **127***a*, **127***b*, and **127***c*, which are dimensioned so that the barrier material parts **33***b*, **33***c*, **33***d* can be accommodated within an enclosing limitation edge **129***a*, **129***b*, or **129***c* of the stabilization device part **119***c* in passage openings **127***a*, **127***b*, and **127***c*.

In another embodiment, no damping sole part **121** is proposed. In this case, the parts of the stabilization device **119***a*, **119***b*, and **119***c* have a flat surface without a limitation edge **129***a*, **129***b*, **129***c*, so that the barrier material **33** is positioned flush with the surface 2Q of the stabilization device in its openings. The composite sole is only formed by the barrier unit, which is constructed from the barrier unit **33**, the stabilization device **119**, and the outsole.

The composite shoe sole parts **105** shown in FIG. **15** are shown obliquely in FIG. **16** in an arrangement separate from one another, but in an oblique view from the bottom. It can be seen that the outsole parts **117***a* to **117***c* are provided in the usual manner with an outsole profile, in order to reduce the danger of slipping. The bottoms of the stabilization device parts **119***a* and **119***e* on their bottom also have several knob-like protrusions **131**, which serve to accommodate the complementary recesses seen in FIG. **15** in the tops of outsole parts **117***a*, **117***b*, and **117***c* for positionally correct joining of the outsole parts **117***a* to **117***c* to the corresponding stabilization device parts **119***a* and **119***c*. Openings **135***a*, **135***b*, **135***c*, and **135***d* are also visible in the stabilization device parts **119***b* and **119***d* in FIG. **16**, which are covered with the corresponding barrier material **33***a*, **33***b*, **33***c*, and **33***d* in a water-vapor-permeable manner, so that the trough holes **31** (FIG. **4**) of the composite shoe sole **105** are closed in a water-vapor-permeable manner. In one embodiment, the barrier materials are arranged so that their smooth surface is directed toward the outsole. The openings **135***a* to **135***d* are each bridged with a stabilization mesh **137***a*, **137***b*, **137***c*, and **137***e*, which form a stabilization structure in the area of the corresponding opening of the stabilization device **119**. These stabilization meshes **137***a*-**137***e* also act against the penetration of larger foreign objects up to the barrier material **33** or even farther, which could be felt as unpleasant by the user of the shoe.

Connection elements **139**, provided on the axial ends of the stabilization part **119***b* on the midfoot side, must also be mentioned, which, during assembly of the stabilization device **119** from the three stabilization device parts **119***a* to **119***c*, can lie overlapping on the upper side of the stabilization-device parts **119***a* and **119***c* facing away from the outsole application side, in order to be attached there, for example, by welding or gluing.

FIG. **17** shows, in an enlarged view compared to FIG. **16**, the two stabilization-device parts **119***a* and **119***b* before attaching to each other, whereby the openings **135***b* to **135***d* of the stabilization device part **119***c* on the forefoot side and the stabilization mesh structure situated in it can be seen in particular. It is also clear that the middle stabilization device part **119***b* shows raised frame and mesh parts on the longitudinal sides. The barrier material piece **33***a* to be placed on the stabilization device part **119***b*, is provided on its long sides with correspondingly raised side wings **141**. Through these raised parts, both the shoe-stabilization part **119***b* and the barrier material piece **33***a*, an adjustment to the shape of the lateral midfoot sides is achieved. The remaining barrier material parts **33***b* to **33***d* are essentially flat, corresponding to the essentially flat design of the stabilization-device part **119***c* on the forefoot side.

It should be added in general here that the at least one opening **135***a*-**135***d* of the stabilization device **119***b* and **119***c* is bounded by the frame **147** of the stabilization device **119** and not by the bars **37** present in the openings **135***a*-**135***d*. The limitation edges **129***a*-**129***c* depicted in FIG. **17** represent part of the corresponding frame **147** in this embodiment.

It is also possible, instead of several barrier-material parts **33***b*, **33***c*, **33***d*, to use a one-piece barrier-material part. The mounting protrusions **150** and/or limitation edges **129***a*-**129***c* must be configured accordingly.

Another modification of the barrier-unit part provided for the midfoot area with the stabilization device part **119***b* and the barrier material part **33***a* is shown in FIGS. **18** and **19**: in FIG. **18** in the finished mounted state and in FIG. **19** while these two parts are still separate from each other. In contrast to the embodiment in FIG. **17**, in the modification of FIGS. **18** and **19**, the stabilization part **119***b* provided for the midfoot area is only provided with an opening and a stabilization mesh **137***a* situated in it in the middle area, whereas the two wing parts **143** on the long sides of the stabilization device part **119***b* are designed to be continuous, i.e., have no opening, but are only provided on their bottom with stabilization ribs **145**. The barrier-material piece **33***a* provided for this barrier-unit part is accordingly narrower than in the embodiments of FIGS. **18** to **19**, because it does not require the side wings **141** according to FIG. **17**.

While embodiments of the composite shoe sole according to the invention **105** were explained with reference to FIGS. **12** to **19**, embodiments in details of footwear according to the invention will now be explained with reference to FIGS. **20** through **27**, the footwear being constructed with the composite shoe sole according to the invention. FIGS. **20**, **22**, and **23** show a embodiment of the footwear according to the invention in which the shaft bottom has a shaft-mounting sole and also a functional-layer laminate, while FIGS. **24** and **25** show a embodiment of footwear according to the invention in which a shaft-bottom functional-layer laminate **237** simultaneously assumes the function of shaft-mounting sole **233**. FIG. **26** shows another embodiment of the composite shoe sole **105**.

In the two embodiments depicted in FIGS. **20** to **25**, the shoe **101**, in agreement with FIGS. **12** and **13***a-d*, has a shaft **103** that has an outer material layer **211** situated on the outside, a liner layer **213** situated on the inside, and a waterproof, water-vapor-permeable shaft functional layer **215** situated in between, for example, in the form of a membrane. The shaft functional layer **215** can be present in connection with the lining layer **213** as a two-ply laminate or as a three-ply laminate, whereby the shaft functional layer **215** is embedded between the liner layer **213** and a textile backing **214**. The upper shaft end **217** is closed or open with respect to the foot-insertion opening **113** (FIG. **12**), depending on whether the sectional plane of the cross-sectional view depicted in FIGS. **24** and **20** lies in the forefoot area or the midfoot area. On the shaft-end area **219** on the sole side, the shaft **103** is provided with a shaft bottom **221**, with which the lower end of the shaft **103** on the sole side is closed. The shaft bottom **221** has a shaft-mounting sole **223**, which is connected to the shaft-end area **219** on the sole side, which occurs in the embodiments according to FIGS. **20** through **25** by means of a Strobel seam.

In the case of the embodiments of FIGS. **20**, **22**, and **23**, in addition to the shaft-mounting sole **233**, a shaft-bottom functional layer laminate **237** is provided, which is arranged beneath the shaft-mounting sole **233** and extends beyond the periphery of the shaft-mounting sole **233** into the shaft-end area **219** on the sole side. The shaft-bottom functional layer laminate **237** can be a three-ply laminate, whereby the shaft-bottom functional layer **248** is embedded between a textile backing and another textile layer. It is also possible to provide the shaft-bottom functional layer **247** with the textile backing only. The outer material layer **211** in the shaft end area **219** on the sole side is shorter than the shaft functional layer **215**, so that a protrusion of the shaft functional layer **215** with respect to the outer material layer **211** is created there and exposes the outer surface of the shaft functional layer **215**. Mostly for mechanical tension relief of the protrusion of the shaft functional layer **215**, a mesh band **241** or another material that can be penetrated with sealant is arranged between the end **238** of the outer material layer **211** on the sole side and the end **239** of the shaft functional layer **215** on the sole side, the long side of which, facing away from the Strobel seam **237**, is joined by means of a first seam **243** to the end **238** of the outer material layer **211** on the sole side, but not to the shaft functional layer **215**, and whose long side, facing the Strobel seam **235**, is joined by means of Strobel seam **235** to the end **239** of the shaft functional layer **215** on the sole side and to the shaft mounting sole **233**. The mesh band **241** preferably consists of a monofilament material, so that it has no water conductivity. The mesh band is preferably used for molded-on soles. If the composite sole is attached to the shaft by means of glue instead of the mesh band, the end **238** of the outer material layer **211** on the sole side can be attached by means of glue **249** to the lasting-shaft functional-layer laminate (FIG. **22**). In the peripheral area **245**, in which the shaft-bottom functional layer laminate **237** protrudes beyond the periphery of the shaft mounting sole **233**, a sealing material **248** is arranged between the shaft-bottom functional layer **237** and the end **239** of the shaft functional layer **215** on the sole side, by means of which a waterproof connection is produced between the end **239** of the shaft functional layer **215** on the sole side and the peripheral layer **245** of the shaft-bottom functional layer laminate **237**, this seal acting through the mesh band **241**.

The mesh-band solution depicted in FIGS. **20**, and **23** to **25** serves to prevent water that runs down or creeps down on the outer material layer **211**, from reaching the Strobel seam **235** and advancing into the shoe interior from there. This is prevented by the fact that the end **238** of the outer material layer **211** on the sole side ends at a spacing from the end **239** of the shaft functional layer **215** on the sole side, which is bridged with the non-water-conducting mesh band **241**, and the sealing material **247**, is provided in the area of the protrusion of the shaft functional layer **215**. The mesh-band solution is known from document EP 0,298,360 B1.

Instead of the mesh-band solution, all joining technologies used in the shoe industry for preferably waterproof joining of a shaft to the shaft bottom can be used. The depicted mesh-band solution and the lasting solution in FIG. **2** are example embodiments.

The shaft structure depicted in FIG. **24** agrees with the shaft structure shown in FIG. **20**, with the exception that no separate shaft-mounting sole is provided there, but the shaft-bottom functional-layer laminate **237** simultaneously assumes the function of a shaft-mounting sole **233**. According to it, the periphery of the shaft-bottom functional layer laminate **237** of the embodiment depicted in FIG. **24** is connected by a Strobel seam **235** to the end **239** on the sole side of the shaft functional layer **215** and the sealing material **248** is applied in the area of the Strobel seam **235**, so that the transition between the end **239** on the sole side of the shaft functional layer **215** and the peripheral area of the shaft-bottom functional-layer laminate **237** is sealed completely, including the Strobel seam **235**.

In both embodiments of FIGS. **20** and **24**, an identically constructed composite show sole **105** can be used, as shown in these two diagrams. Since sectional views of shoes **101** are shown in the forefoot area in FIGS. **20** and **24**, these diagrams are a sectional view of the forefoot area of the composite shoe sole **105**, i.e., a sectional view along an intersection line running across the stabilization unit part **119***c* intended for the forefoot area with the barrier material piece **33***c* inserted in its openings **135***c*.

The sectional view of the composite shoe sole **105** accordingly shows the stabilization device part **119***c* with its opening **135***c*, a bar of the corresponding stabilization mesh **137***c* bridging this opening, the outward protruding frame **129***b*, the barrier material piece **33***c* inserted into the frame **129***b*, the damping sole part **121***b* on the top side of the stabilization device part **119***c*, and the outsole part **117***b* on the bottom of the stabilization device part **119***c*. To this extent, the two embodiments of FIGS. **20** to **24** correspond.

FIG. **21** shows an example of a barrier unit **35**, in which a piece of barrier material **33** is provided on the bottom with at least one stabilization bar **37**. On the surface area of the barrier material **33** opposite the stabilization bar **37**, an adhesive **39** is applied, with which the barrier material **33** is joined to the waterproof, water-vapor-permeable shaft bottom **221**, which is situated above the barrier unit **35** outside the composite shoe sole. The glue **39** is applied in such a way that the shaft bottom **221** is joined to the barrier material **33** wherever no material of the stabilization bar **37** is situated on the bottom of the barrier material **33**. In this way, it is ensured that the water-vapor-permeability function of the shaft bottom **115** is interfered with by glue **39** only where the barrier material **33** cannot permit any water-vapor transport in any case, because of the arrangement of the stabilization bar **37**.

Whereas the corresponding composite shoe sole **105** in FIGS. **20** and **24** is still separated from the corresponding shaft **103**, FIGS. **22**, **23**, and **25** show, in an enlarged view and as a cutout, these two embodiments with the composite shoe sole **105** applied to the shaft bottom. In these enlarged views, the shaft-bottom functional layer **247** of the shaft-bottom functional-layer laminate **237**, in all embodiments, is preferably a microporous functional layer, for example, made of expanded polytetrafluoroethylene (ePTFE). As already mentioned above, however, different types of functional layer materials can also be used.

In these enlarged cutout views of FIGS. **22**, **23**, and **25**, the waterproof connection between the overlapping opposite ends of the shaft functional layer **215** and the shaft-bottom functional layer **247** created with the sealing material **248** can be seen particularly well. In addition, the involvement of a longitudinal mesh-band side in the Strobel seam **235** can also be seen more readily in FIGS. **20** and **24**.

FIG. **22** shows an embodiment, in which the composite sole **105** according to the invention is attached by means of attaching glue **250** to the shaft bottom. The shaft functional-layer laminate **216** is a three-ply composite with a textile layer **214**, a shaft functional layer **215**, and a lining layer **213**. The end **238** of the outer material layer **211** on the sole side is attached with lasting glue **249** to the shaft functional-layer laminate **216**.

The attaching glue **250** is applied superficially to the surface of the composite sole, except for the trough holes **135** and the barrier material **33** arranged in the area of trough holes **135**. When the composite sole is attached to the shaft bottom **221**, the attaching glue **250** penetrates up to and partially into the shaft functional-layer laminate **216** and up to and partially into the edge areas of the shaft-bottom functional layer laminate **237**. FIG. **23** is a view of the shaft structure according to FIG. **20** with a molded-on composite shoe sole. The three-ply shaft-bottom functional-layer laminate **237** is then attached to the shaft mounting sole **233**, so that the textile backing **246** faces the composite sole. This is advantageous, because the sole-molding material **260** penetrates more easily into the thin textile backing and can be anchored there and a firm connection to the shaft-bottom functional layer **237** is created.

The barrier unit with the at least one opening **135** in the at least one piece of barrier material **33** is present as a prefabricated unit and is inserted into the injection mold before the molding process. The sole-molding material **260** is molded onto the shaft bottom accordingly, advancing up to the shaft functional-layer laminate **216** through the mesh band **241**.

FIG. **25** shows an enlarged and sectional view of FIG. **24**. The composite sole **105** shows an additional embodiment of the barrier unit according to the invention. The shaft-stabilization device **119***c* forms a part of the composite sole **105** and does not extend here to the outer periphery of the composite sole **105**. A piece of barrier material **33***c* is applied over the opening **135**, so that the material **33***c* lies on the peripheral continuous flat limitation edge **130** of opening **135**.

The composite sole **105** can be attached to the shaft bottom **221** with attaching glue **250** or molded on with sole-molding material **260** (as shown).

FIG. **25** also clearly shows that in the embodiment in which the shaft-bottom functional layer laminate **237** assumes the function of a shaft-mounting sole **233**, the laminate comes to lie directly above the opposite top of the barrier material piece **33***c*, which is particularly advantageous. In this case, an air cushion that might adversely affect water-vapor removal cannot form between the shaft-bottom functional layer laminate **237** and the barrier material piece **33***c*, and the barrier material piece **33***c*, and especially the shaft-bottom functional layer **237**, are situated particularly tight against the foot sole of the user of such a shoe, which improves water-vapor removal, which is also determined by the existing temperature gradient between the shoe interior and the shoe exterior.

FIG. **26** is a view of another embodiment of the composite sole according to the invention. The perspective view shows several openings **135** in the shoe-stabilization device **119**, which are arranged from the toe area to the heel area of the composite sole. The stabilization material **33** is therefore also present in the heel area. The outsole is formed by the outsole parts **117**.

FIG. **27** is a view of another embodiment of the composite sole according to the invention in a cross-sectional view. The composite sole **105** of this embodiment is quite similar to the composite sole depicted in FIG. **24**. The composite sole **105** according to FIG. **27** has an outsole, in which a cross-section through the ball of the foot area of the composite sole **105** and therefore a cross-section through the corresponding outsole part **117***b* is shown in this diagram. However, the disclosure according to FIG. **27** also applies to the other areas of the composite sole **105**, i.e., to its midfoot part and heel part. The outsole part **117***b* has a tread **153** that touches the floor during walking. The sectional view of the composite sole **105** of FIG. **27** shows the stabilization-device part **119***c* with its opening **135***c*, its upward protruding limitation edge **129***b*, the barrier material piece **33***c* inserted into the limitation edge **129***b*, the damping sole part **121***b* on the upper side of the stabilization device part **119***c*, and the outsole part **117***b* on the bottom of the stabilization part **119***c*. A support element **151** is applied to the bottom of the barrier material piece **133***c*. This extends from the side of the barrier material **33** facing the tread to the level of tread **153**, so that the barrier material **33** is supported on the floor during walking by the support element **151**. This means that a lower free end of the support element **151** in FIG. **27** touches this surface when the shoe provided with this composite sole stands on a surface. Through this support by the support element **151**, during walking on such a surface, the barrier material piece **33***c* is held essentially in the position depicted in FIG. **27**, so that it is prevented from bending under the load of the user of the shoe. Several support elements **151** can be arranged in opening **135***c*, in order to increase the support effect for the barrier material piece **33***c* and make its surface extent more uniform.

The support function can also be obtained by the fact that the stabilization bar **137** depicted in FIG. **24** is simultaneously formed as the support element **151** by allowing the stabilization bar **137***c* not to end at a spacing from the bottom of the outsole part **117***b* serving as the tread, but extending it to the level of this bottom. The stabilization bar **137***c* is then given the dual function of stabilizing and supporting the barrier-material piece **33***c*. For example, the stabilization bars **33***c* depicted in FIG. **10** or the stabilization mesh **37***d* depicted in FIG. **11** can be formed fully or partially as support elements **151**.

With the sole structure according to the invention, a high water-vapor permeability is achieved, because, on the one hand, large-area trough holes in the composite shoe sole **105** are provided and these are closed with material of high water-vapor permeability, and because, at least in the area of the trough holes **31**, there are no connections between the water-vapor-permeable barrier material **33** and the shaft-bottom functional layer **247** that prevent water-vapor exchange, and such a connection is, at most, present in the areas outside the trough holes **31** of the composite shoe sole **105** that do not participate actively in water-vapor exchange, such as the edge areas of the composite shoe sole **105**. In the structure according to the invention, the shaft-bottom functional layer **247** is also arranged tightly in the foot, which leads to accelerated water-vapor removal.

The shaft-bottom functional-layer laminate **237** can be a multilayer laminate with two, three, or more layers. At least one functional layer is contained with at least one textile support for the functional layer, whereby the functional layer can be formed by a waterproof, water-vapor-permeable membrane **247**, which is preferably microporous.

Test Methods

Thickness

The thickness of the barrier material according to the invention is tested according to DIN ISO 5084 (October 1996).

Puncture Resistance

The puncture resistance of the textile fabric can be measured with a measurement method used by the EMPA ([Swiss] Federal Material Testing and Research Institute), using a test device of the Instrom tensile-testing machine (model 4465). A round textile piece 13 cm in diameter is punched out with a punch and attached to a support plate in which there are 17 holes. A punch, on which 17 spike-like needles (sewing needle type 110/18) are attached, is lowered at a speed of 1000 mm/min far enough that the needles pass through the textile piece into the holes of the support plate. The force for puncturing the textile piece is measured by means of a measurement sensor (a force sensor). The result is determined from a test of three samples.

Waterproof Functional Layer/Barrier Unit

A functional layer is considered "waterproof," optionally including the seams provided on the functional layer, when it guarantees a water-penetration pressure of at least 1×10^4 Pa. The functional-layer material preferably guarantees a water penetration pressure of more than 1×10^5 Pa. The water penetration pressure is then measured according to a test method in which distilled water, at 20±2° C., is applied to a sample of 100 cm^2 of the functional layer with increasing pressure. The pressure increase of the water is 60±3 cm H_2O per minute. The water-penetration pressure corresponds to the pressure at which water first appears on the other side of the sample. Details concerning the procedure are provided in ISO standard 0811 from the year 1981.

Waterproof Shoe

Whether a shoe is waterproof can be tested, for example, with a centrifugal arrangement of the type described in U.S. Pat. No. 5,329,807.

Water-Vapor Permeability of the Barrier Material

The water-vapor permeability values of the barrier material according to the invention are tested by means of the so-called beaker method according to DIN EN ISO 15496 (September 2004).

Water-Vapor Permeability of the Functional Layer

A functional layer is considered "water-vapor-permeable", if it has a water-vapor permeability number, Ret, of less than 150 $m^1\times Pa\times W^{-1}$. The water-vapor permeability is tested according to the Hohenstein skin model. This test method is described in DIN EN 31092 (February 1994) or ISO 11092 (1993).

Water-Vapor Permeability of the Shoe-Bottom Structure According to the Invention

In an embodiment of the footwear according to the invention with a shoe-bottom structure that includes the composite shoe sole and the shaft-bottom functional layer or the shaft-bottom functional layer laminate situated above it, the shoe-bottom structure has a water-vapor permeability (MVTR—moisture vapor transmission rate) in the range from 0.4 g/h to 3 g/h, which can lie in the range from 0.8 g/h to 1.5 g/h and in a practical embodiment, is 1 g/h.

The extent of water-vapor permeability of the shoe-bottom structure can be determined with the measurement method documented in EP 0,396,716 B1, which is conceived for measuring the water-vapor permeability of an entire shoe. To measure the water-vapor permeability of only the shoe-bottom structure of a shoe, the measurement method according to EP 0,396,716 B1 can also be used, in which the measurement is made with the measurement layout depicted in FIG. 1 of EP 0,396,716 B1 in two consecutive measurement scenarios, namely once for the shoe with a water-vapor-permeable shoe-bottom structure and another time for an otherwise identical shoe with a water-vapor-impermeable shoe-bottom structure. From the difference between the two measurements, the percentage of water-vapor permeability that is attributed to the water-vapor permeability of the water-vapor-permeable shoe-bottom structure can be determined.

In each measurement scenario, using the measurement method according to EP 0,396,716 B1, the following sequence of steps was used:

a) Conditioning of the shoe by leaving it in an air-conditioned room (23° C., 50% relative humidity) for at least 12 hours.
b) Removal of the insert sole (foot bed)
c) Lining the shoe with a waterproof, water-vapor-permeable lining material adapted to the shoe interior, which, in the area of the foot insertion opening of the shoe, can be sealed waterproof and water-vapor-tight with a waterproof, water-vapor-impermeable sealing plug (for example, made of Plexiglas and with an inflatable sleeve).
d) Filling water into the lining material and closing the foot-insertion opening of the shoe with the sealing plug.
e) Preconditioning the water-filled shoe by leaving it for a predetermined period (3 hours), during which the temperature of the water is kept constant at 35° C. The climate of the surrounding room is also kept constant at 23° C. and 50% relative humidity. The shoe is blown against frontally by a fan during the test with a wind velocity, on average, of at least 2 m/s to 3 m/s (to destroy a resting air layer that forms around the standing shoe, which would cause a significant resistance to water-vapor passage).
f) Reweighing the shoe filled with water and sealed with the sealing plug after preconditioning (result: weight m2 (g))
g) Standing again in a test phase of 3 hours under the same conditions as in step e)
h) Reweighing the sealed water-filled shoe (result: weight m3 (g)) after the 3-hour test phase
i) Determining the water-vapor permeability of the shoe from the amount of water vapor that escapes through the shoe during the test time of 3 hours (m2−m3) (g) according to the relation M=(m2−m3) (g)/3(h).

After both measurement scenarios have been conducted, in which the water-vapor-permeability values are measured, on the one hand, for the entire shoe with a water-vapor-permeable shoe-bottom structure (value A) and, on the other hand, for the entire shoe with the water-vapor-impermeable[1] shaft-bottom structure (value B), the water-vapor-permeability value for the water-vapor-permeable shoe-bottom structure alone can be determined from the difference A-B.

[1] Translator's Note: The German word, "wasserdampfdurchlässigen" should be "wasserdampfundurchlässigen. Changed in translation.

It is important during measurement of water-vapor permeability of the shoe with the water-vapor-permeable shoe-bottom structure to avoid a situation where the shoe or its sole stands directly on a closed substrate. This can be achieved by raising the shoe or by positioning the shoe on a mesh structure, so that it is ensured that the ventilation air stream can flow along—or, better beneath—the outsole.

It is useful in each test layout to make repeated measurements for a certain shoe and to consider the averages from them, in order to be able to estimate the measurement scatter better. At least two measurements should be made for each shoe with the measurement layout. In all measurements, a natural fluctuation of the measurement results of ±0.2 g/h around the actual value, for example, 1 g/h, should be assumed. For this example, measured values between 0.8 g/h and 1.2 g/h could therefore be determined for the identical shoe. Influencing factors for these fluctuations could be the person performing the test or the quality of sealing on the upper shaft edge. By determining several individual measured values for the same shoe, a more exact picture of the actual value can be obtained.

All values for water-vapor permeability of the shoe-bottom structure are based on a normally cut men's shoe of size 43 (French size), whereby the statement of the size is not standardized and shoes of different manufacturers could come out differently.

There are essentially two possibilities for the measurement scenarios:

1. Measurement of shoes with a water-vapor-permeable shaft, having

1.1 a water-vapor-permeable shoe-bottom structure;

1.2 a water-vapor-impermeable shoe-bottom structure;

2. Measurement of shoes with a water vapor-impermeable shaft, having

2.1 a water-vapor-permeable shoe-bottom structure,

2.2 a water-vapor-impermeable shoe-bottom structure.

Elongation and Tensile Strength

An elongation and tensile-strength test was conducted according to DIN EN ISO 13934-1 of April 1999. Instead of five samples per direction, three were used. The spacing of the clamping jaws was 100 mm in all samples.

Abrasion

With respect to abrasion resistance, two measurement methods were used for the abrasion measurements to obtain the abrasion values in the comparison table. In the first place, a Martindale abrasion tester was used ("abrasion carbon" in the table), in which, according to Standard DIN EN ISO 124940-1; -2 (April 1999), the sample being tested is rubbed against sandpaper. Three deviations from the standard are then made: first, sandpaper with grain 180 plus standard foam is tightened in the sample holder. Second, standard felt from the test sample is tightened in the sample table. Third place, the sample is inspected every 700 passes and the sandpaper is changed. On the other hand, the abrasion resistance was tested in wet samples (in the table "abrasion wet") according to DIN EN ISO 12947-1, -2, -4; with the deviation from the standard that the sample table with standard felt and standard wool were saturated with distilled water every 12,800 passes.

In the abrasion tests, friction movements according to Lissajous figures were conducted. Lissajous figures represent a periodically repeating overall picture during a corresponding choice of the ratio of participating frequencies, which consist of individual figures offset relative to each other. Passage through one of these individual figures is referred to as a pass in connection with the abrasion test. In all materials 1 to 5, it was measured after how many passes the first holes occurred in the corresponding material and the material had therefore been scraped through. In the comparison table, two pass values are found for each of the materials, which were formed from the two abrasion tests with the same material.

Hardness

Hardness test according to Shore A and Shore D (DIN 53505, ISO 7819-1, DIN EN ISO 868)

Principle:

"Hardness according to Shore" is understood to mean the resistance to penetration of an object of a specific shape and defined spring force. The Shore hardness is the difference between the numerical value 100 and the penetration depth of the penetration object in mm under the influence of the test force divided by the scale value 0.025 mm.

During testing according to Shore A, a truncated cone with an opening angle of 35° is used as the penetration object, and in Shore D, a cone with an opening angle of 30° and a tip radius of 0.1 mm is used. The penetration objects consist of polished, tempered steel.

Measurement Equation:

$$HS = 100 - \frac{h}{0.025}$$

$$F = 550 + 75\ HSA$$

$$F = 445\ HSD$$

H in mm, F in mN

Area of Application:

Because of the different resolution of the two Shore hardness methods in different hardness ranges, materials with a Shore A hardness >80 are appropriately tested according to Shore D and materials with a Shore D hardness <30 according to Shore A.

Hardness scale	Application
Shore A	Soft rubber, very soft plastic
Shore D	Hard rubber, soft thermoplastic material

DEFINITIONS

Barrier Material:

A material that enables the shoe or parts/materials present in the shoe, such as outer material, sole, membrane, to be mechanically protected and resist deformation, and also penetration of external objects/foreign bodies, for example, through the sole, while retaining high water-vapor transport, i.e., high climate comfort in the shoe. The mechanical protection and resistance to deformation are mostly based on limited elongation of the barrier material.

Fiber Composite:

General term for a composite of fibers of any type. This includes leather, non-woven materials, or knits consisting of metal fibers, under some circumstances, also in a blend with textile fibers, also yarns and textiles produced from yarns (fabrics).

A fiber composite must have at least two fiber components. These components can be fibers (for example, staple fibers), filaments, fiber elements, yarns, strands, etc. Each fiber component consists either of a material or contains at least two different material fractions, one fiber part softening/melting at a lower temperature than the other fiber part (bico). Such bico fibers can have a core-shell structure—a core fiber part enclosed with a shell fiber part here, a side-to-side structure or an island-in-the-sea structure. Such processing and machines are available from Rieter Ingolstadt, Germany and/or Schalfhorst in Mönchengladbach, Germany.

The fibers can be simply spun, multifilament, or several torn fibers with frayed ends looped to one another.

The fiber components can be distributed uniformly or nonuniformly in the fabric composite.

The entire fabric composite must preferably be temperature-stable, but at least to 180° C. A uniform and smooth surface on at least one side of the fiber composite is achieved by means of pressure and temperature. This smooth surface points "downward" to the ground/floor, so that a situation is achieved in which particles/foreign objects bounce off the smooth surface better or are repelled more simply.

The properties of the surface or overall structure of the fiber composite or stabilization material depend on the selected fibers, the temperature, the pressure, and the period over which the fiber composite was exposed to temperature and pressure.

Non-Woven Material:

Here, the fibers are laid on a conveyor belt and tangled.

Lay:

A fishnet or sieve structure of the fibers. See EP 1,294,656 from Dupont.

Felt:

Wool fibers that are opened and hooked by mechanical effects.

Woven Fabric:

A fabric produced with warp and weft threads.

Woven and Knit Fabric:

A fabric formed by meshes

Melting Point:

The melting point is the temperature at which the fiber component or fiber part becomes liquid. Melting point is understood, in the field of polymer or fiber structures, to mean a narrow temperature range in which the crystalline areas of the polymer or fiber structure melt and the polymer converts to a liquid state. It lies above the softening temperatur range and is a significant quantity for partially crystallized polymers. Molten means the change of state of aggregation of a fiber or parts of a fiber at a characteristic temperature from solid to viscous/free-flowing.

Softening Temperatur Range:

The second fiber component of the second fiber part must only become soft/plastic, but not liquid. This means the softening temperatur used lies below the melting point at which the components/fractions flow. The fiber component or parts of it are preferably softened, so that the more temperature-stable component is embedded or incorporated in the softened parts.

The first softening temperatur range of the first fiber component lies higher than the second softening temperatur range of the second fiber component or the second fiber part of the second fiber component. The lower limit of the first softening range can lie below the upper limit of the second softening temperatur range.

Adhesive Softening Temperature:

The temperature, at which softening of the second fiber component or the second fiber part occurs, at which its material exerts a gluing effect, so that at least part of the fibers of the second fiber component are thermally bonded to one another by gluing, a bonding stabilization of the fiber component occurs, which is greater than the bonding obtained in a fiber composite with the same materials for the two fiber components by purely mechanical bonding, for example, by needle bonding of the fiber composite. The adhesive softening temperatur can also be chosen in such a way that softening of the fibers of the second fiber component occurs to an extent that gluing develops not only of fibers of the second fiber component to one another, but also partial or full enclosure of the individual sites of the fibers of the first fiber composite with softened material of the fibers of the second fiber composite occurs, i.e., partial or full embedding of those sites of the fibers in the first fiber composite in the material of the fibers of the second fiber component, so that a correspondingly increased stabilization bonding of the fiber composite is produced.

Temperature Stability:

If the stabilization device is molded-on, the barrier material must be temperature-stable for molding. The same applies to molding (about 170° C.-180° C.) or vulcanization of the shoe sole. If the stabilization device is to be molded-on, the barrier material must have a structure such that the stabilization device can at least penetrate into the structure of the barrier material, or optionally penetrate through it.

Functional Layer/Membrane:

The shaft-bottom functional layer, and optionally the shaft functional layer can be formed by a waterproof, water-vapor-permeable coating or a waterproof, water-vapor-permeable membrane, which can either be a microporous membrane or a membrane having no pores. In one embodiment of the invention, the membrane is expanded polytetrfluoroethylene (ePTFE).

Appropriate materials for a waterproof, water-vapor-permeable functional layer include: polyurethane, polypropylene, polyester, including polyether-ester, and laminates thereof, as described in documents U.S. Pat. No. 4,725,418 and U.S. Pat. No. 4,493,870. However, expanded microporous polytetrafluoroethylene (ePTFE) is particularly preferred, as described, for example, in documents U.S. Pat. No. 3,953,366 and U.S. Pat. No. 4,187,390, and expanded polytetrafluoroethylene provided with hydrophilic impregnation agents and/or hydrophilic layers; see, for example, document U.S. Pat. No. 4,194,041. A "microporous functional layer" is understood to mean a functional layer whose average pore size lies between about 0.2 μm and about 0.3 μm.

The pore size can be measured with a Coulter Porometer (trade name), which is produced by Coulter Electronics, Inc., Hialeah, Fla., USA.

Barrier Unit:

The barrier unit is formed by the barrier material, and optionally by the stabilization device in the form of at least one bar and/or frame. The barrier unit can be present in the form of a prefabricated component.

Composite Shoe Sole:

A composite shoe sole consists of barrier material and at least one stabilization device and at least one outsole, as well as optionally additional sole layers, whereby the barrier material closes at least a trough hole extending through the thickness of the composite shoe sole.

Trough Hole:

A trough hole is an area of the composite shoe sole, through which water-vapor transport is possible. The outsole and the stabilization devices each have passage openings that overall form a trough hole through the entire thickness of the composite shoe sole. The trough hole is therefore formed by the intersection surface of the two passage openings. Any bars present are arranged within the peripheral edge of the corresponding trough hole and do not form a limitation of the trough hole. The area of the trough hole is determined by subtracting the area of all bridging bars, since these bar surfaces block water-vapor transport and therefore do not represent trough hole surfaces.

Stabilization Device:

The stabilization device acts as additional stabilization of the barrier material and is formed and applied to the barrier material in such a way that the water-vapor permeability of the barrier material is only slightly influenced, if at all. This is achieved by the fact that only a small area of the barrier material is covered by the stabilization device. The stabilization device is preferably directed downward toward the floor. The stabilization device is primarily assigned not a protective function, but a stabilization function.

Opening of the Stabilization Device:

The at least one opening of the stabilization device is bounded by its at least one frame. The area of an opening is determined by subtracting the area of all bridging bars.

Shoe:

A foot covering consisting of a composite shoe sole and a closed upper (shaft).

Shoe Bottom:

The shoe bottom includes all layers beneath the foot,

Thermal Activation:

Thermal activation occurs by exposing the fiber composite to energy, which leads to an increase in temperature of the material to the softening temperatur range.

Water-Permeable Composite Shoe Sole:

A composite shoe sole is tested according to the centrifuge arrangement of the type described in U.S. Pat. No. 5,329,807. Before testing, it must be ensured that any shaft-bottom functional layer present is made water-permeable. A water-permeable composite shoe sole is assumed if this test is not passed. If necessary, the test is conducted with a colored liquid, in order to show the path of electricity through the composite shoe sole.

Laminate:

Laminate is a composite consisting of a waterproof, water-vapor-permeable functional layer with at least one textile layer. The at least one textile layer, also called a backing, primarily serves to protect the functional layer during processing. We speak here of a two-ply laminate. A three-ply laminate consists of a waterproof, water-vapor-permeable functional layer embedded between two textile layers, spot-gluing being applied between these layers.

Waterproof Functional-Layer/Barrier Unit:

A functional layer is considered “waterproof,” optionally including seams provided on the functional layer, if it guarantees a water-penetration pressure of at least 1×10^4 Pa.

Top of the Composite Shoe Sole:

The “top” of the composite shoe sole is understood to mean the surface of the composite shoe sole that lies opposite the shaft bottom.

Outsole:

“Outsole” is understood to mean the part of the composite shoe sole that touches the floor/ground or produces the main contact with the floor/ground.

LIST OF REFERENCE NUMBERS

1 Fiber composite
2 First fiber component
3 Second fiber component
4 Core
5 Shell
6 Connection
21 Composite shoe sole
23 Outsole
25 Shoe-stabilization device
27 Outsole opening
29 Shoe-stabilization device opening
31 Trough hole
33 Barrier material
33*a* Barrier material
33*b* Barrier material
33*c* Barrier material
33*d* Barrier material
35 Barrier unit
37 Stabilization bar
37*a* Individual bar
37*b* Individual bar
37*c* Individual bar
37*d* Stabilization mesh
39 Glue
43 Circular surface
101 Shoe
103 Shaft
105 Composite shoe sole
107 Forefoot area
109 Midfoot area
111 Heel area
113 Foot insertion opening
115 Shaft bottom
117 Multipart outsole
117*a* Multipart outsole heel area
117*b* Multipart outsole ball of foot area
117*c* Multipart outsole toe area
119 Stabilization device
119*a* Heel area
119*b* Midfoot area
119*c* Forefoot area
121 Damping sole part
121*a* Damping sole part heel area
121*b* Damping sole part midfoot area
[**123**] Outsole openings
123*a* Heel area
123*b* Midfoot area
123*c* Forefoot area
125 Passage opening in the heel area **119***a* of a stabilization device
[**127**] Openings in the damping sole part
127*a* Heel area
127*b* Midfoot area
127*c* Forefoot area
[**129**] Limitation edge of the shoe stabilization device
129*a* Midfoot area
129*b* Forefoot area
129*c* Forefoot area
131 Protrusions
133 Recesses
[**135**] Stabilization-device openings
135*a* Midfoot area
135*b* Forefoot area
135*c* Forefoot area
135*d* Forefoot area
[**137**] Stabilization mesh
137*a* Midfoot area
137*b* Forefoot area
137*c* Forefoot area
137*d* Forefoot area
139 Connection element
141 Side wings
143 Wing parts stabilization device
145 Stabilization rib
147 Fraying of stabilization device
150 Support protrusion
151 Support element
153 Tread
211 Outer material layer
213 Lining layer
214 Textile layer
215 Shaft functional layer
216 Shaft functional-layer laminate
217 Upper shaft end
219 Shaft-end area on the sole side
221 Shaft bottom
233 Shaft mounting sole
235 Strobel seam
237 Shaft-bottom functional-layer laminate
238 End of the outer material layer on the sole side
239 End of the shaft functional layer on the sole side
241 Seam band

243 First seam
244 Textile layer
245 Peripheral layer
246 Textile backing
247 Membrane
248 Sealing material
249 Lasting glue
250 Attaching glue
260 Sole-molding material

COMPARATIVE TABLE

Material type	Sole split leather	Non-woven material, only needle-bonded	Woven material, only needle-bonded	Non-woven material, needle-bonded and thermally bonded	Non-woven material, needle-bonded, thermally bonded; thermal surface compression with 3.3 N/cm^2/230° C./10 s
Material number	Material 1	Material 2	Material 3	Material 4	Material 5
Material	100% leather	100% PES	100% PES	PES + bico PES total 100% PES	PES + bico PES total 100% PES
Basis weight (g/m^2)	2383	206	125	398	397
Thickness (mm)	3.36	2.96	2.35	1.71	1.46
MVTR (g/m^2 24 h) (1)	3323	8086	9568	9459	9881
Longitudinal elongation at 50N (%)	1	34	55	0	0
Longitudinal elongation at 100N (%)	2	48	79	1	0
Longitudinal elongation at 150N (%)	2	59	104	1	0
Longitudinal tensile force (N)	3106	324	152	641	821
Longitudinal tensile elongation (%)	40	94	107	26	27
Transverse elongation at 50N (%)	0	32	46	0	0
Transverse elongation at 100N (%)	1	43	63	1	0
Transverse elongation at 150N (%)	1	52	75	1	0
Transverse tensile force (N)	4,841	410	252	884	742
Transverse tensile elongation (%)	43	92	99	35	32
Puncture resistance (N)	857	5	6	317	291
Abrasion wet (passes) (2)	25,600/30,100	20,600/20,600	20,700/16,500	70,200/70,200	614,000/704,000
Abrasion carbon (passes) (2)	about 35,000	1,570/1,600	452/452	7,700/7,700	14,000/15,400

(1) DIN EN ISO 15496 (September 2004)
(2) DIN EN ISO 12947-1, -2 (April 1999)

Men's shoe size 42/43 (French)

Test time: 3 hours

All shafts constructed identically, i.e., scatter only through natural scatter of the materials (leather, textile, etc.)

Shaft can be designed waterproof
Constant water amount in all shoes
Insert soles removed for the test
Shoe-bottom structures in numbers 2 and 3 comparable: In no. 1 only the outsole is closed, i.e., it has no openings

Shoe number	Repetition measurements	Sole water-vapor-permeable? YES/NO	Air stream over the shaft and under the sole	Weight m2 (g) before beginning of test	Weight m3 (g) after the end of the test	Total shoe water-vapor permeability MVTR = (m2 − m3)/test time (g/h)	Average value of repetition measurements per shoe number MVTR (g/h)	Water-vapor permeability of the shoe-bottom structure (g/h)
1	1	No	Yes	1106.66	1097.55	3.0	3.1	0
1	2	No	Yes	1103.58	1095.03	2.8		
1	3	No	Yes	1102.98	1094.63	2.8		
1	4	No	Yes	1112.44	1102.54	3.3		
1	5	No	Yes	1143.9	1133.75	3.4		

-continued

Shoe number	Repetition measurements	Sole water-vapor-permeable? YES/NO	Air stream over the shaft and under the sole	Weight m2 (g) before beginning of test	Weight m3 (g) after the end of the test	Total shoe water-vapor permeability MVTR = (m2 − m3)/test time (g/h)	Average value of repetition measurements per shoe number MVTR (g/h)	Water-vapor permeability of the shoe-bottom structure (g/h)
1	6	No	Yes	1108.58	1098.42	3.4		
1	7	No	Yes	1102.62	1094.15	2.8		
1	8	No	Yes	1101.78	1093.16	2.9		
1	9	No	Yes	1117.55	1107.86	3.2		
2	1	Yes	Yes	1179.2	1167.06	4.0	4.0	4.0 − 3.1 = 0.9
2	2	Yes	Yes	1156.7	1144.85	4.0		
2	3	Yes	Yes	1144.65	1132.97	3.9		
2	4	Yes	Yes	1159.46	1148.3	3.7		
2	5	Yes	Yes	1153.56	1142.5	3.7		
2	6	Yes	Yes	1175.88	1163.36	4.2		
2	7	Yes	Yes	1173.78	1160.84	4.3		
2	8	Yes	Yes	1165.54	1153.05	4.2		
3	1	Yes	Yes	1153	1140	4.3	4.3	4.3 − 3.1 = 1.2
3	2	Yes	Yes	1168.42	1156.17	4.1		
3	3	Yes	Yes	1160.6	1146.98	4.5		
3	4	Yes	Yes	1183.8	1170.5	4.4		

The invention claimed is:

1. Footwear comprising:

a water-vapor-permeable composite shoe sole with an upper side comprising

at least one through hole extending through the thickness of the composite shoe sole;

a barrier unit with an upper side forming at least partially the upper side of the composite shoe sole and with a water-vapor-permeable barrier material designed as a barrier against penetration of foreign objects, by means of which the at least one through hole is closed in a water-vapor-permeable manner;

a stabilization device in communication with the barrier material, designed for mechanical stabilization of the composite shoe sole, which is constructed with at least one stabilization bar, which is arranged at least on one surface of the barrier material and at least partially bridges at least one through hole;

and at least one outsole part arranged beneath the barrier unit;

wherein the barrier material has a fiber composite with at least two fiber components that differ with respect to their melting point;

whereby at least one part of a first fiber component has a first melting point and a first softening temperature range lying beneath it, and at least one part of a second fiber component has a second melting point and a second softening temperature range lying beneath it, and the first melting point and the first softening temperature range are higher than the second melting point and the second softening temperature range; and

whereby the fiber composite is thermally bonded, while retaining water-vapor-permeability in the thermally bonded area, as a result of thermal activation of the second fiber component with an adhesive softening temperature lying in the second softening temperature range,

said footwear having a shaft, which is provided on a shaft end area on the sole side with a waterproof and water-vapor-permeable shaft-bottom functional layer, whereby the composite shoe sole is joined to the shaft end area provided with the shaft-bottom functional layer, so that the shaft-bottom functional layer is not bonded to the barrier material, at least in the area of the at least one through hole.

2. Footwear according to claim 1, in which the shaft is constructed with at least one shaft material, whereby the shaft material has a waterproof shaft functional layer at least in the area of the shaft end area on the sole side, and whereby between the shaft functional layer and the shaft-bottom functional layer, a waterproof seal exists.

3. Footwear according to claim 1, whose shaft-bottom functional layer is assigned to a water-vapor-permeable shaft-mounting sole.

4. Footwear according to claim 1, whose shaft-bottom functional layer is part of a multilayer laminate.

5. Footwear according to claim 4, whose shaft-mounting sole is constructed with the laminate.

6. Footwear according to claim 1, whose shaft-bottom functional layer, and optionally the shaft functional layer, have a waterproof, water-vapor-permeable membrane.

7. Footwear according to claim 6, whose membrane has expanded polytetrafluoroethylene.

8. Footwear according to claim 1, with a shoe-bottom structure, having the composite shoe sole and the shaft-bottom functional layer situated above it, in which the shoe-bottom structure has a water-vapor transmission rate (MVTR) in the range from 0.4 g/h to 3 g/h.

9. Footwear according to claim 8, whose shoe-bottom structure has a water-vapor transmission rate (MVTR) in the range from 0.8 g/h to 1.5 g/h.

10. Footwear according to claim 9, whose shoe-bottom structure has a water-vapor transmission rate (MVTR) of 1 g/h.

11. A method for producing footwear with a water-vapor-permeable composite shoe sole with an upper side comprising

at least one through hole extending through the thickness of the composite shoe sole;

a barrier unit with an upper side forming at least partially the upper side of the composite shoe sole and with a water-vapor-permeable barrier material designed as a barrier against penetration of foreign objects, by means of which the at least one through hole is closed in a water-vapor-permeable manner;

a stabilization device in communication with the barrier material, designed for mechanical stabilization of the composite shoe sole, which is constructed with at least one stabilization bar, which is arranged at least on one surface of the barrier material and at least partially bridges at least one through hole;

and at least one outsole part arranged beneath the barrier unit;

wherein the barrier material has a fiber composite with at least two fiber components that differ with respect to their melting point;

whereby at least one part of a first fiber component has a first melting point and a first softening temperature range lying beneath it, and at least one part of a second fiber component has a second melting point and a second softening temperature range lying beneath it, and the first melting point and the first softening temperature range are higher than the second melting point and the second softening temperature range; and

whereby the fiber composite is thermally bonded, while retaining water-vapor-permeability in the thermally bonded area, as a result of thermal activation of the second fiber component with an adhesive softening temperature lying in the second softening temperature range; and

a shaft that is provided on a shaft end area on the sole side with a waterproof and water-vapor-permeable shaft-bottom functional layer with the following process steps:

a) the composite shoe sole and shaft are prepared;

b) the shaft is provided on the shaft end area on the sole side with a waterproof and water-vapor-permeable shaft-bottom functional layer;

c) the composite shoe sole and the shaft end area on the sole side provided with the shaft-bottom functional layer are joined to each other in such a way, that the shaft-bottom functional layer is not bonded to the barrier material, at least in the area of the at least one through hole.

12. A method according to claim **11**, in which the shaft end area on the sole side is closed with the shaft-bottom functional layer.

13. A method according to claim **11** for production of footwear, whose shaft is provided with a shaft functional layer, whereby a waterproof joint is produced between the shaft functional layer and the shaft-bottom functional layer.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,351,534 B2
APPLICATION NO. : 13/693316
DATED : May 31, 2016
INVENTOR(S) : Marc Peikert et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the title page, item (72) Inventors:

Please correct a spelling of the first inventor's name from Mark Peikert to -- Marc Peikert --.

Signed and Sealed this
First Day of November, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office